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SCIENTIFIC AND CULTURAL CO-OPERATION

ONE factor which has hindered constructive discussion in Great Britain of the United Nations Educational, Scientific and Cultural Organisation is the comparative inaccessibility of many of the official documents. Although reports of the Beirut Conference last year do not yet appear to be available, the publication of Dr. Julian Huxley's second report as director-general (see p. 457), covering the activities of the Organisation during 1948, has made possible a fresh appreciation of the value and prospects of the Organisation. Together with a debate in the House of Lords on January 26, it serves to correct some ill-informed criticisms, and indicates both some of the achievements to the credit of Unesco and some weaknesses that require attention.

Reference was made to this report in the House of Lords debate, notably by the Bishop of Chichester; but this reference gave no idea of the value and scope of Dr. Huxley's valedictory message. Even more valuable than his detailed account of activities, which on some points of presentation is open to criticism, is the general survey which precedes the detailed report. In this survey Dr. Huxley picks out for emphasis special features of the work of the Organisation which he regards as specially important or noteworthy. He then indicates certain difficulties inherent in the early years of a young organisation and some achievements which warrant confidence in its future. Next he deals with some current criticism of its activities, and, suggesting that the unifying idea behind all the activities of Unesco is the advance of world civilization, he records finally some of the conclusions which he has reached as a result of the three years he has spent with the Organisation.

Before examining Dr. Huxley's conclusions, it is as well to note that both the report and speakers in the House of Lords debate clearly distinguished between the administrative weaknesses and the character as well as the execution of the programme of the United Nations Educational, Cultural and Scientific Organisation. These two aspects have been much confused in current criticism, and it should be noted that, as Lord Addison pointed out, in replying to the debate on behalf of the Government, great improvements have already been made on the administrative side in the financial control. The statement on this point made by the auditors, which Lord Addison quoted, is explicit and re-assuring. While the laxity in the expenditure of public money in 1946 cannot be condoned, there can be little room for doubt that the Organisation is outgrowing some of those administrative difficulties inherent in any body which is staffed by several nationalities.

Policy, however, or the general programme of the Organisation, is another matter from accounts or day-to-day administration, and it is here that much criticism appears to be unsound and sometimes badly misplaced. Dr. Huxley's report should help to put matters into a true perspective and to stimulate constructive criticism at the points where it is most needed and where it can be most effective. The

general approval of the central idea of promoting a better understanding between the peoples of the whole world which lies behind all the activities of Unesco has not prevented a considerable amount of criticism of the general policy and tendencies of the Organisation; and the one main criticism which Dr. Huxley is disposed to admit is that greater attention should be given to the formulation of a central idea or aim which the ordinary citizen can understand and appreciate. It is for this reason that, as already indicated, he suggests that the underlying idea is the advance of world civilization. The advance of civilization on a world basis is regarded by him as both practical and concrete, the summation of a series of definite and limited tasks, without introducing a note of ideological theory. It commends itself immediately to the educated portion of the world's population and can be readily made intelligible and desirable to the rest. It can readily be fitted into the broader concept of evolutionary progress but is quite independent of it.

Dr. Huxley does not attempt to formulate a detailed definition, but directs attention to the large area of common agreement as to the meaning of his terms. The advancement of civilization clearly implies the better cultivation of the arts of peace; the advance of knowledge and the exploration of new outlets for creative activity and expression; the emergence of new enjoyments and new possibilities of individual and social development; and, in terms of Unesco's competence, although it demands an increasingly complex material basis and social organisation as its foundation, it is primarily concerned with science and culture and with education as the method of transmitting them. In arguing thus, Dr. Huxley does not over-stress the place of science and scientific technique, the dominance of which was deplored in the House of Lords debate by the Bishop of Chichester, who stoutly challenged the view that science by itself could do much to improve the world, and pleaded eloquently that in the future development of the Organisation special attention should be paid to culture in all the richness of the meaning of that word. This speech, although a protest against excessive preoccupation with the material aspects of civilization, clearly recognized that science itself is one of the cultural elements in human life. Dr. Huxley similarly suggests that the advance of civilization consists essentially in the development of the higher activities of the human mind and spirit which can be shared without being destroyed or divided quantitatively. The idea of world civilization, moreover, transcends both nationalism and the collaboration of separate sovereign nations, and one suggestion put forward by Dr. Huxley for consideration is that Unesco should delegate an important part of its work to private individuals chosen, not as official delegates of Governments, but as leaders of civilization—outstanding thinkers, artists, writers and men of science, owning their allegiance not to nations but to humanity—representatives of departments of the human mind. Such private individuals would be in a position, Dr. Huxley believes, to give a lead to a unitary world civilization on many subjects where official delegates would be restrained; and in particular that only to such individuals could be entrusted the task of defining the phrase 'world civilization' and of describing what Unesco should do for its advancement. He visualizes the growth in this way of another international non-governmental organisation which would possibly act as a general spearhead for the Organisation.

This outlook is probably too optimistic, as is also the theme that the advance of world civilization necessarily excludes ideological differences. It is the totalitarian systems that represent the greatest obstacle, far greater than ascetic philosophy; for they deny the human freedoms on which creative activity depends, and they would render sterile and ineffective the participation of individuals, however eminent, in such an organisation as is suggested. They deny the loyalty to a world civilization which is presupposed, and require subscription to new dogmas which may not be scrutinized by the free spirit of scientific inquiry.

That obstacle has to be recognized; but nevertheless it is right to advocate increasing delegation of discussion in particular fields to the unofficial and individual level. Much of Unesco's most valuable work has, in fact, been done in this way. Already, the International Scientific Unions are functioning more effectively because of the help given to them by the Organisation, which has contributed during 1947 and 1948 about half a million dollars in grants-in-aid to the Unions, and has been instrumental in the formation of a new International Union for the Protection of Nature.

The wisdom of using existing organisations in this way cannot be challenged, and with its fellowship programme, facilitating the interchange of men of science and other scholars and its work in the reconstruction and rehabilitation of learned institutions, the Organisation has solid achievements to its credit.

Two of these spheres of work should find a permanent place in the programme of the Organisation, even when the reconstruction and rehabilitation work is completed and the "Book of Needs" no longer issued. Moreover, it will be noted that totalitarian regimes such as Soviet Russia have taken no more part in such activities than they have in Unesco itself, a fact that in itself demonstrates how far we have yet to go before we can speak with any sense of universality of a 'world civilization'. That, however, constitutes the real challenge to the creative and constructive thinking that should precede both criticism of Unesco's present programme and the formulation of alternative plans for achieving human understanding.

The very existence of the United Nations Educational, Scientific and Cultural Organisation is a challenge to men of science, philosophers, artists, writers, teachers and thinkers everywhere. To achieve a deeper sense of intellectual and moral solidarity between the nations of the world is an exacting task, but may be a condition of the survival of mankind. The methods by which it is to be achieved may still require discovery, and the task is far too large and important to be left to the permanent officials and

delegations of the Organisation alone. It is already clear that American men of science are making a real attempt at such constructive thinking, as are shown by Dr. Bok's article "Unesco and the Physical Sciences" in a recent issue of the *Bulletin of the Atomic Scientists* and the replies received to the inquiry on "Science and the Maintenance of Peace" initiated last June by the Committee on Science and its Social Relations of the International Council of Scientific Unions. British scientific workers and other men of learning will have to co-operate more fully with their American and other colleagues to enable the purposes of Unesco to be achieved and its projects stripped of the vagueness of which Lord Simon in particular commented in the House of Lords.

Certain other points in Dr. Huxley's report should help in such thinking. He stresses, for example, the need for giving closer attention to the raising of education, science and culture to the international plane; and, indeed, beyond that to a plane where they can be treated as aspects of the welfare of humanity as a whole. For support he looks to a *rapprochement* between scientific method and empirical practice in the higher reaches of human psychology. The social sciences have also important contributions to make to the solution of such problems as the mobilization of leaders of thought and creative expression throughout the world to carry forward the idea of a world civilization; they assist both governments and peoples to comprehend the importance of the arts and of the æsthetic and emotional, as well as the scientific and intellectual, foundations of a world civilization.

The comparative neglect of art by Unesco is recognized by Dr. Huxley; but here, as in the field of culture generally, great care and constant scrutiny by creative, practical minds will be needed to see that projects do not become vaguely idealistic. Last but not least, what he has to say about Unesco's contribution to world peace deserves attention. The programme of the Organisation is, it is true, in large part designed to lay the foundations for a more united and peaceful world; but this should not be taken to mean that all its activities must be directly and immediately relevant to the preservation of peace. Some of its effort must be directed towards setting up the mechanism required for the existence of a truly peaceful world; but that mechanism in itself is no guarantee of peace and could even in certain circumstances be turned against peace.

To provide a clearing house of information, a common pool of information on which all nations can draw in solving their own immediate educational, scientific and cultural problems, to assist the more efficient organisation of research in the natural and the human and social sciences so as to facilitate the solution of the problems of humans as a whole—these are recognized as essential elements in the function of adapting knowledge for the common good. No less important is that of distributing grants in aid of approved projects, whether their execution is entrusted to Unesco itself or to other bodies, and the need for careful scrutiny and constructive criticism of such projects; nevertheless, Dr. Huxley is right in pointing out that concentration on three or four projects would not suffice to achieve the real purpose of Unesco, and to secure that men in all nations recognized and accepted a new and compelling loyalty.

We can, in fact, only be content that Unesco should concentrate for the present on a short-term programme provided that the creative thinking that must form the basis for long-term schemes is proceeding. We are only on the threshold of learning how to treat tensions affecting international understanding, and there is little to guide us along sound lines of approach. Professional associations, not only of scientific workers but also of teachers, writers, artists and many others, can make a vital contribution to the work of the Organisation in such matters. Dr. Huxley's report contains much material to stimulate the thought which will be required. British men of learning will surely not fail to follow the outstanding lead already given in the United States, and take a worthy part in the elaboration of an adequate programme and also in ascertaining the philosophical foundations for it.

MODERN RESEARCH IN RETINAL PHYSIOLOGY

Sensory Mechanisms of the Retina

With an Appendix on Electroretinography. By Dr. Ragnar Granit. Pp. xxiii+412. (London, New York and Toronto: Oxford University Press, 1947.) 35*s*. net.

THIS book is not a general treatise on vision, but deals in detail with some additions to visual physiology in the last fifteen years that have been derived from the study of action potentials of the retina and the optic nerve, and particularly with work in this field with which the author has been closely associated and in which his laboratory has been notably active. It has been possible in many types of visual sense organ to record nerve impulse discharges set up by the stimulus of light; in work on a simple eye (*Limulus*), Hartline showed that visual sense cells, like other sensory nerve endings that have been investigated, set up impulses of frequency related to the strength of the stimulus, and Hartline later confirmed this for single optic-nerve fibres from the frog's retina. But here the response was complicated by fibres responding when the light was extinguished—the well-known off-discharge found by Adrian and R. Matthews in the eel's optic nerve. Granit's work has extended this investigation to mammalian eyes; and the response in single optic-nerve fibres in many eyes has been studied and related to the wave-length of the light evoking it.

The author's dominator-modulator theory of colour vision is considered in detail, though the elaborate transformations to which the experimental results are subjected in order to yield the modulator curves are scarcely sufficiently stressed, nor are the many assumptions implicit in these transformations considered. Hartline has given clear evidence in the frog's retina of the large number of retinal elements converging on to a single optic-nerve ganglion cell. Granit's work has shown that both rods and cones converge on a common final path. It seems to the

reviewer that Granit's observations have not demonstrated the presence of distinct pathways for the clearly distinguished modalities required to fit any of the existing colour-vision theories. As the existence for specific colour pathways has not been clearly demonstrated, if animals possess wave-length discrimination, it must be considered whether it is possible that the modalities can be transmitted by a single fibre by the pattern of impulses occurring in the final common path. There is some evidence in Granit's work, briefly mentioned, that the relative proportions of the on- and off-discharge of a single fibre are greatly influenced by the wave-length of incident light; this observation would appear to merit much more consideration than it has yet been given, and more detailed experimental exploration. It certainly suggests an escape from the present impasse produced by many observations that all the receptors present appear to converge on similar final common paths in the optic nerve; and it is difficult, therefore, to see how the higher centres can be informed of the particular receptors stimulated except by the patterns of nerve impulses occurring.

The book contains a wealth of interesting matter from the author's own experimental work taken from his many recent papers; but as a review of recent advances in retinal physiology it is a pity that more rigid selection was not used to reduce the excess of detail so that general principles would be more clearly defined. This makes the book more valuable to the specialist than to the student; unfortunately, much of the detail given is in deduction from experiment without the experimental observations from which alternative treatments of the data might be tested.

The wealth of detail in the present volume shows clearly that visual physiology is in a state of rapid advance and almost embarrassed by the wealth of observation that has yet to be fitted into the theory; for the theory has not yet advanced sufficiently to accommodate all the newer observations, which sometimes, therefore, appear to be conflicting.

The volume is well produced with nearly two hundred illustrations and a large bibliography.

B. H. C. MATTHEWS

PHYSICAL CHEMISTRY OF HIGH-POLYMERIC SYSTEMS

The Chemistry of High-Polymers

By Prof. C. E. H. Bawn. Pp. x+249. (London: Butterworth's Scientific Publications, Ltd., 1948.) 17*s*. 6*d*. net.

NOTABLE advances in our knowledge of the physical chemistry of high-polymeric systems have been made by British chemists. This is particularly true of those parts of this subject concerned with the mechanism and kinetics of addition polymerization of vinyl compounds, the thermodynamics of solutions of rubber, the application of physical methods to the elucidation of structure, and the behaviour of high polymers under applied stresses. It is therefore the more surprising that the book under review is the first on this subject to be published in Great Britain. If such a volume has been long overdue, Prof. C. E. H. Bawn's book has been well worth waiting for and, in the reviewer's opinion, deserves, and will probably secure, a much wider range of readers than that for which it was written.

The complete study of a single high-polymeric system is especially instructive because it illustrates such a variety of chemical principles and problems. First comes the preparation, in the desired degree of purity, of the basic material to be polymerized. This, largely organic, aspect is omitted by Prof. Bawn, and it might therefore be argued that his title should read "The *Physical* Chemistry of High-Polymers". Next, the chemical route must be discovered by which the monomer is transformed to the polymer. Accordingly, the early chapters are accounts of the kinetics of the rate of formation, and the molecular size distributions, of the product. Two major routes are distinguished: polycondensation and addition polymerization. The former is much the simpler kinetically and involves the consideration of only one velocity constant. Addition polymerization processes have all the complexity of chain reactions and involve the following: initiation processes, which may be stimulated by catalysts or radiation or both, and suppressed by inhibitors; propagation reactions and their reverse; chain transfer; and termination by a variety of methods. Such complexity makes clarity of presentation at once essential and difficult to attain without loss of continuity, and the author is to be congratulated on the large measure in which he has succeeded. Minor corrections and omissions are bound to arise. For example, on p. 55 a mechanism for destruction of diradicals by *p*-benzoquinone is presented which is contrary to Melville's findings, and the expression at the bottom of p. 15 for photochemical initiation must surely be $f(\mathrm{IM})$.

Polymer molecules are the very antithesis of the idealized collision-theory concept of an incompressible sphere. Their size and shape can be determined by very varied observations on solutions of polymers. These methods are critically discussed, and the author is careful to emphasize that owing to the flexibility of the chains the results obtained only refer to the condition of the polymer in the particular solvent concerned. The gross disparity between the size of an extended polymer-chain and a solvent molecule implies that the entropy of dilution is far from ideal. If the interactions between polymer pairs, solvent pairs and polymer-solvent pairs are also widely different, appreciable heats of solution may be expected. Both these factors must be disentangled and their origins understood if the colligative and other properties of polymer solutions are to be significant. Chapters 4–5 are models of clear elementary expositions of these topics.

The author next considers what can be discovered concerning the finer structure, that is to say, the molecular architecture, of polymers. The mechanism of formation is often suggestive, and chemical analysis may provide an answer of partial validity; but the least ambiguous methods are the analyses of the absorption spectra and X-ray diffraction patterns. The latter tool is particularly valuable also for the clues which it can provide as to the degree of crystallinity of a solid polymer.

Many lecture audiences will have seen 'bouncing putty', which typifies the unusual physical properties that a polymer may display. Appreciable progress towards the understanding of the causes of the various types of response to applied mechanical and electrical constraints has been made in the last ten years, and the author has given a lucid account of these researches.

In such a vast field, any author of an elementary text must be selective, and any reviewer must resist the temptation to complain if his hobby-horses are not ridden, provided the book fulfils the purpose for which it was written. Prof. Bawn has achieved his object brilliantly, and there can be little doubt that his book will rapidly and deservedly become a standard university text.

The publishers of the book have departed from the usual English scientific book practice in certain respects. *Times* New Roman type has been employed, and this contributes greatly to the ease of reading. The same cannot be said of the other features. There is no author index, and the subject index is both incomplete and badly cross-referenced. Where sub-divisions of sentences or paragraphs occur, brackets are rarely placed round the number or letter. This makes for difficult reading even when the letters are italicized. On p. 46, brackets are employed, and the pleasing contrast with the earlier part of the same paragraph where they are omitted is most noticeable.

F. S. DAINTON

MOHENJO-DARO AND HARAPPA

Early Indus Civilizations

By Dr. Ernest Mackay. Second edition, revised and enlarged by Dorothy Mackay. Pp. xiv + 169 + 30 plates. (London: Luzac and Co., Ltd., 1948.) Stiff paper, 15*s.*; cloth, 17*s.* 6*d.*

STUDENTS of Indian archæology will welcome this second edition of Dr. E. Mackay's useful text-book on the Indus civilizations. The magnificent volume of Sir John Marshall on "Mohenjo-daro and the Indus Civilization" is far too expensive for the average archæologist, and the other publications of the Archæological Survey of India are also expensive and not easily accessible. In this new edition the illustrations have been enlarged and increased in number; but it is a pity that the amulets referred to on pages 59–60 are not included in the additional illustrations

Interpolations have also been made in the text to bring it up to date in accordance with the results of field-work carried out since the first edition was published, and an addendum at the end gives a general view of the conclusions to be drawn from this later work. Thus the linking up of Harappa material with Sumerian and Babylonian chronology involves a consequential change in Harappa dating which would nearly, if not quite, bridge the gap between the Indus civilization and the invasion of the Aryan-speakers. This implies a very long period at Harappa with a remarkably slow rate of change. There is nothing inherently improbable in this, and a parallel can be found in the continuing culture of Atchama-Alalakh which was reported by Sir Leonard Woolley in 1947. Other examples can be provided from Arabia, and such a slow rate of change is probably typical of India. It is not impossible that the cities and wealth of the Dasyus, Nagas, etc., mentioned in the Rigveda and the early epics, have reference to the Indus civilization, and that the tradition which describes the Dasyus as black and noseless may have been taken over from a race of previous invaders and interpreted in the course of time as referring to the immediate precursors of the Aryan-speakers.

The graphs on the seals are also discussed, but it is unlikely that these inscriptions will be deciphered until some bilingual record with a second character has been discovered.

The index has been extended, and there have been added an air photograph of the Mohenjo-daro site and plans of the city. The number of plates has been doubled, but the absence of scale is a serious drawback; for example, there is nothing on the plate to tell the student that the steatite bust depicted on Plate 16 is not life-size, instead of being, as it is, on a miniature scale; one may be permitted to hope that the next edition will give not only scales to the illustrations, but also some reference to the relative pages of the text.

J. H. HUTTON

BEQUEST TO BIRD-LOVERS

Birds in Britain

By Frances Pitt. Pp. viii+576+17 plates. (London: Macmillan and Co., Ltd., 1948.) 25*s.* net.

DURING the Second World War the amount of bird-watching and the number of bird-lovers in Britain increased considerably. This has led to a steady stream of books on birds and their behaviour, to cater both for the experienced bird-watcher and for the enthusiastic beginner. But no apologia need be made for the appearance of yet another book on birds, since "Birds in Britain" is the fourth of the now well-established "in Britain" series which have been enthusiastically received by many readers. Previous issues in the series have dealt with flowers, trees and dogs, and now comes Miss Frances Pitt with her long experience and discerning eye. In her book are found not only scientific accounts of wild and domestic birds in Britain but also personal anecdotes which enliven the text and captivate the reader. Her experiences have been gathered in many parts of the British Isles and have given her an 'understanding' of birds which, by description, she successfully transmits to her readers. These descriptions are supplemented in many instances by well-chosen and apt literary references both from the classics and lesser-known works.

Nor is the text the only delightful feature of this book. The frontispiece consists of a painting by Winifred Austen on which it would be hard to improve either in the original or as a reproduction. Roland Green has painted a series of sixteen plates which, because of their natural effects, are a joint tribute to artist and publishers. Miss Pitt herself has contributed a number of clear, explanatory line drawings, and the book is also provided with a large number of black-and-white photographs drawn from the rich store of our leading bird photographers. The reproduction of some of these is probably the only blemish in a book which will be of value to the specialist, and generate enthusiasm with the not so learned. For the specialist better accounts of certain topics like "Birdsong", "Migration" and "Territorial Behaviour" may be found elsewhere; but it is probable that of all works on birds this book comes nearest to providing something of interest both for the specialist and the novitiate. There is evidence that its predecessors have helped to kindle the enthusiasm of many beginners in the study of trees and flowers, and it will not be surprising to learn later that "Birds in Britain" has increased the number and knowledge of bird-lovers in Britain.

T. H. HAWKINS

Symposium on Methods of Penicillin Assay

Their Purpose, Scope and Validity. (The Society of Public Analysts and Other Analytical Chemists: Physical Methods Group and Biological Methods Group.) Pp. iv + 34. (Cambridge: W. Heffer and Sons, Ltd., 1948.) 3*s*. 6*d*. net.

MUCH of the value of scientific symposia and conferences is apt to be lost in these days of publication difficulties. For example, the papers read at the International Congress of Pure and Applied Chemistry some eighteen months ago remain unpublished, except as abstracts on bits of common paper. It is therefore especially commendable that the Society of Public Analysts and Other Analytical Chemists (like the Biochemical Society also) has achieved relatively prompt publication of symposium papers. The symposium on "Methods of Penicillin Assay" was held on January 29, 1948, and was reported in *Nature* of February 21, p. 285. The papers and discussion were published in the April and May issues of *The Analyst*, and have since been reprinted as a handy stiff-covered booklet, uniform with reports of previous symposia on polarography, chromatography and spectroscopic analysis. The report can probably claim to cover every known method (about forty in all) for assaying total penicillin or individual penicillins, by chemical, physical or biological means. Its importance lies not only in this completeness, but also in the fact that some of these methods have not been published previously, except in war-time reports of limited availability. It is unfortunate that some important methods are mentioned only in the introductory surveys, and therefore briefly, while there are full papers on others of less importance. However, this kind of uneven weighting is inevitable at any symposium.

Working Plans for Estate Woodlands

By N. D. G. James. Pp. ix+93. (Oxford: Basil Blackwell, 1948.) 6*s*. 6*d*. net.

IN the past it was not so much the owners of estates as their factors and agents who were against the 'working plans' for woodlands. It is all to the good that Mr. N. D. G. James emphasizes in a book of considerable merit the importance of the necessity for making plans for small woodlands. He explains clearly enough the form the plan should take, and how information and statistics should be collected. This is all good, concise and clear. He correctly insists on the formation of compartments and other allotments or divisions of the areas, but a serious omission is that nothing is said about yield calculation; this title is even omitted from the headings given of the plan. The intention is expressed of not wishing to frighten owners with complexities and unnecessary technicalities, but one cannot call the calculation of the yield either the one or the other, for the necessity is obvious.

I am unable to follow the author in his divisions of the 'working plan' into three under the titles of a "Full Plan", an "Intermediate Plan" and a "Short Plan". The 'working plan' remains as such whether made for (1) a large area of forest with at present only a small demand for its produce and thus requiring only a simple plan; (2) a large area of forest under intensive management requiring detailed plans; or (3) an area of simple coppice requiring only a simple prescription. The main headings of the 'working plan' are the same for all, and any modifications required can be made in the prescriptions, such as planting, natural regeneration, felling proposals and so forth. It is suggested that pages 6–15 dealing with the headings of the three types of plan are likely to prove intimidating to the owner. Altogether this book is quite a good piece of work in many of its parts; the omission of any methods of calculating the yield is a pity. In his fear of becoming complicated and complex in items of management, the author seems to have unnecessarily complicated simplicity.

E. P. STEBBING

Poudres et explosifs

Par Henri Muraour. (Que sais-je?, les points des connaissances actuelles, No. 259.) Pp. 136. (Paris: Presses universitaires de France, 1947.) n.p.

THE author of this volume has had unusual experience in writing about his subject; the present work is mainly addressed to those with some scientific background who wish to have a brief but broad account of the nature, classification and testing of organic explosives, and of their future military uses as propellants, in minefields, and for demolition purposes. The format somewhat resembles that of the 'Penguin' series.

For those with some acquaintance with the subject, interest will centre on the chapter on the decomposition process, which includes records of work by the author and his colleagues. The detonation of initiators *in vacuo* is explained by a chain mechanism in which activated decomposition-products bring about further reaction by 'resonance' with unchanged molecules. The *brisant* nature of initiators may be annulled if they are ignited in a high-pressure gas; this phenomenon is left unexplained, pending further investigation.

For high-explosives, the hydrodynamic theory, as elaborated by Schmidt, Jouguet and others, is adopted. Here the experiments of Muraour have included studies of the luminosities of shock waves in monatomic gases; the higher figures found in argon as compared with helium are explained as being due to the higher atomic weight. Vassy found that four millilitres of a mixture of tetranitromethane and toluene, when detonated in argon, gave an intensity of four hundred million candle-power in a flash lasting four millionths of a second. Comparison of these shock-wave intensities with those produced by meteors promises to give interesting results.

W. E. BATTY

Directory of Museums and Art Galleries in the British Isles

Compiled by Major S. F. Markham. Pp. viii+392. (London: Museums Association, 1948.) n.p.

ALTHOUGH much of the information contained in this directory is also available in the Libraries, Museums and Art Galleries Yearbook, 1948, those who are not chiefly requiring information about libraries or about overseas institutions will probably find the directory the more convenient to use. The information given is slightly fuller, and some details are supplied of museums closed through lack of local interest or of financial support, those destroyed or damaged by enemy action and those occupied by Government departments. Museums closed at December 1947 are listed in an appendix, with remarks on the situation and prospects of re-opening. Although the volume includes no index, the alphabetical arrangement by towns and villages is adequate for most purposes, and the book is well printed and produced.

R. B.

NINTH INTERNATIONAL CONFERENCE OF WEIGHTS AND MEASURES

THE ninth International Conference of Weights and Measures was held in Paris in October last. Under the terms of the international treaty known as the Convention du Mètre, these Conferences should be held every six years. But on this occasion the Conference which should have taken place in the autumn of 1939 had had to be deferred, owing to the Second World War, until 1948, with the result that the normal interval was increased to fifteen years.

In the meantime the International Bureau of Weights and Measures at Sèvres had pursued its activities, though not without difficulties both financial and technical, due to the abnormal conditions of the times. In particular, the International Committee which governs the Bureau under the general authority of the Conference was also unable to meet between 1937 and 1945. It will be appreciated that, in these circumstances, many changes had occurred in the interval, and the 1948 Conference had before it an unusually heavy agenda.

The opening session took place in the Salon d'Horloge at the Ministry of Foreign Affairs in Paris, under the presidency of the French Foreign Minister, M. Robert Schuman. Subsequent meetings were held at the International Bureau under the presidency of M. Henri Villat, the president, or his deputy, M. Louis de Broglie, the permanent secretary of the Paris Academy of Sciences. The members were also entertained by M. Vincent Auriol, the French President, at an informal reception at the Elysée.

The Conference was attended by fifty-five representatives of twenty-eight States adhering to the Convention. Only five States were unable to send delegates: two of them, Germany and Japan, because, at the time, they were without autonomous Governments. Great Britain was represented by Sir Charles Darwin, director of the National Physical Laboratory, Mr. H. Barrell, the official delegate, and Mr. J. E. Sears, president of the International Committee, which was in session concurrently with the Conference and functioned in an advisory capacity. It will doubtless be remembered that the International Committee itself enjoys the assistance of three technical consultative committees, for electricity, for photometry and for thermometry and calorimetry.

The first session was purely formal, being confined to a speech of welcome by M. Schuman, and replies by Mr. Sears and M. Villat. The first business at the second session was the establishment of the credentials of the official Government delegates who held the right of vote for their respective States. At this stage there was an intervention by the Russian delegation, who objected to the presence of Spanish representatives at the Conference; they directed attention to the refusal of the United Nations to admit Spain to membership. It was pointed out that the Convention du Mètre had no connexion with U.N.O., that its functions were entirely non-political, and that each contracting State, having paid its subscription, was equally entitled to participate in the proceedings of the Conference. Although the Russian delegation formally reserved the right to revert to this question, it was not, in fact, raised again.

The Conference then proceeded to the consideration of the various items on its agenda. Mr. Sears reported on the activities of the Bureau since the previous Conference, in 1933, and asked for formal sanction to the results of comparisons made, during the past fifteen years, of various national copies of the metre and kilogram. These results were highly satisfactory. With the exception of two kilograms, the masses of which were known to have diminished owing to wear, the new values, both for the metres and the kilograms, agreed, within quantities small enough to be accounted for by the combined errors of the two determinations, with those obtained when the standards were first authorized in 1889. Incidentally, it was reported that the historical Kilogramme des Archives, also included as a matter of interest in the recent recomparisons, showed a diminution of mass of 0·4 mgm. This caused no surprise, as the material of construction of this old weight is known to be inferior to that of the international standards. It may be remarked that the British Standard Pound, the material of which may be supposed to be similar to that of the Kilogramme des Archives, has exhibited a similar loss relative to the current metric standards.

Consideration was next given to the possibility of the eventual replacement of the material prototype standard of the metre, in platinum–iridium, by a definition of the unit of length based on the wave-length of light. This is an old proposal which has received a considerable impetus in recent years as a result of the separation of sensible quantities of isotopic materials—in particular of krypton-84 in Germany and of mercury-198 in the United States. These isotopic elements provide sources of even more homogeneous radiations than the red line of cadmium which has hitherto been accepted as the standard of reference for spectroscopic measurements, and open up the possibility of a new definition of the unit of length, free from the objections hitherto urged against the use of a wave-length of light for this purpose, which would afford the prospect of a clear advance in precision. The Conference voted a resolution recognizing these facts and inviting the principal national laboratories and the Bureau International to pursue the study of these new sources with the eventual object of establishing such a definition.

The next subject to be considered was the value of the acceleration due to gravity. Determinations at the National Physical Laboratory, Teddington, and at the National Bureau of Standards, Washington, have indicated that the accepted reference value for standard gravity, derived from the earlier Potsdam determinations, is appreciably in error. All these values result from pendulum observations. Experiments have already been initiated with the approval of the Committee at the Bureau International with a view to a new determination by direct observation of the movement of a body (a graduated line standard) falling *in vacuo*, using modern techniques for the precise measurement of times and displacements. Recommendations in nearly similar terms were submitted to the Conference by the Russian and Spanish delegations urging the desirability of further gravity determinations. After discussion, the Conference voted a resolution recognizing the interest of the work already in hand at the Bureau, and inviting

other laboratories which may be in a position to do so to undertake comparable measurements.

On the subjects of electric and photometric units, the Conference had little to do except to take note of, and confirm, the decision already taken by the International Committee, in pursuance of the instructions of the previous Conference, that the new units should come into force as from January 1, 1948. It may be worth while to recall that the relationship of the old to the new (absolute) electric units is 1 mean international ohm, $\Omega_M = 1{\cdot}00049$ absolute ohm; 1 mean international volt $V_M = 1{\cdot}00034$ absolute volt; and that the new unit of candle-power, which in future is to be designated 'candela', is defined as "such that the brightness of an integral (black body) radiator, at the temperature of solidification of platinum, equals 60 candela per square centimetre".

With regard to thermometry, the Conference accepted a revised text of the International Temperature Scale, recommended by the International Committee on the advice of its consultative committee. This is a very detailed statement. It may be useful to record that the primary fixed points of the scale are:

	Temperature 0° C.
Boiling point of oxygen	−182·970
Melting point of ice (fundamental point)	0
Boiling point of water (fundamental point)	100
Boiling point of sulphur	444·600
Solidification point of silver	960·8
Solidification point of gold	1063·0

Temperatures in the revised scale are to be quoted as °C. (Int. 1948). It should also be mentioned that, after discussion, it was unanimously agreed to describe temperatures in this scale as degrees "Celsius" instead of Centigrade or Centesimal. Objections were raised to both the latter on different grounds.

Turning to a more fundamental question, it was agreed that the thermodynamic scale should, in principle, be based on a single fixed point, namely, the triple point of pure water, which should have the value + 0·0100 degree, together with the absolute zero, the value of which should be fixed at a later date, when more precise measurements are available.

It was also agreed that the unit of heat should be the 'Joule', and it was remitted to the International Committee to establish a table relating the value of various 'calories' to the Joule, in accordance with the best available experimental data.

The Conference also referred to the Committee the task of instituting an inquiry among all the contracting States as to the opinions held with regard to the possible formulation of a common practical system of units of measurement suitable for adoption by all countries using the metric system, and of making recommendations.

Following an initiative of the International Union of Physics, the Conference adopted a table of nomenclature and symbols relating to a selected group of quantities which were held to come within its domain. It also approved a proposed recommendation that, so far as Europe is concerned, words ending in ". . . illion" should be accepted as referring to successive powers of 10^6.

Approval was given to a proposed agreement for mutual co-operation between the International Committee and the United Nations Educational, Scientific and Cultural Organisation on questions of common interest.

The Conference next addressed itself to the regulation of the scale of subscriptions for the various countries adhering to the Convention. Proposals for further extensions of the activities of the Bureau were put forward by the Russian delegation and referred to the Committee for study. A suggestion was made by the Swiss delegate that the Governments of the contracting States might be invited to supplement their statutory contributions by voluntary donations to facilitate such additional undertakings.

Finally, the Conference proceeded to the re-election of the International Committee. Many members of the Committee elected in 1933 have since died. In addition to seven former members who retain their seats, the following were elected, or re-elected after retirement by rule: L. de Broglie (French), G. Cassinis (Italian), E. C. Crittenden (American), M. Dehalu (Belgian), W. J. de Haas (Dutch), T. Isnardi (Argentine), H. Nagaoka (Japanese), Z. Rauszer (Polish), M. Siegbahn (Swedish).

The Conference passed in an atmosphere of friendly co-operation, and it will be seen that it accomplished successfully a large programme of work covering a very wide field.

EVOLUTION OF COLOUR VISION

A DISCUSSION of the evolution of colour vision took place at the general meeting of the Linnæan Society on February 24. Dr. R. J. Pumphrey, while disclaiming expert knowledge, said that it seemed fitting that a zoologist should have been invited to open the discussion rather than a specialist in human colour vision, however knowledgeable, since a zoological training enforces a historical outlook, which is essential for the ultimate understanding of the evolution of function. The evidence available from animals other than mammals, though extremely relevant, is still scanty; inferences from structure and physiology cannot be relied on. Colour vision can only be ascribed to an animal when the intact animal, either in the field or in a controlled experimental situation, has been shown to exercise a choice depending on colour discrimination. Such a test is always a matter of extreme technical difficulty, and is not applicable to any animal without restriction but only to those whose habits and motivation make them suitable subjects. In spite of these limitations, colour vision has been demonstrated beyond reasonable doubt in a number of insects, notably aculeate Hymenoptera, Diptera and Lepidoptera, and a number of vertebrates, notably teleost fish, reptiles, birds and primates.

This demonstration leads immediately to two obvious questions. To what extent is the fundamental mechanism of colour vision similar in these animals? And to what extent is it utilized in a similar way? To the first question, the best available answer comes from measurements of the least perceptible difference in wave-length ($\Delta\lambda$) of pure spectral colours as a function of wave-length. This function is of identical form for man (Wright), pigeon (Hamilton and Coleman) and minnow (Wolff). The maximum and minimum values of $\Delta\lambda$ occur at the same values of wave-length λ. For the bee the curve has the same general character but is displaced, one minimum value of $\Delta\lambda$ being in the ultra-violet near 3800 A. (Kühn). It is reasonable to conclude that in all these cases colour vision depends on the existence of three

or more types of photoreceptor with different absorption spectra. None of these curves has the least resemblance to the discrimination curve of a human dichromat, although it has been suggested that dichromatism is an essential stage in the evolution of full colour vision.

It does not follow, however, that colour vision has the same character in all these animals. Kühn's work appears to show that the effect known as simultaneous colour contrast, which is of trivial importance in human vision, is dominant for the bee. If this be the case, no object of small angular subtense in the bee's visual field will be intrinsically coloured; its apparent hue will depend primarily on the background against which it is seen.

The human eye unaided cannot distinguish spectral green from a suitable mixture of spectral blue and yellow, but a match so made will no longer be a match when seen through a coloured filter. A proportion of the cones of a bird's retina contains red and yellow oil droplets each of which is a colour filter for its own cone. Hence it is obviously physically possible for a bird to distinguish impure colours which are indistinguishable to man without extraneous aids. These examples indicate that in spite of a fundamentally similar mechanism of colour vision in different animals, the quality and extent of the information about the environment which their eyes collect need not be the same or even similar.

The fact that colour vision appears to be demonstrable in just those animals whose habits lend it a particular importance suggests that the fundamental mechanism is an essential attribute of any highly organised eye, and one which may or may not be exercised in the direction of colour vision according to need. Hartline's and Granit's demonstration of receptors of different spectral sensitivities in the retinæ of a number of animals which are certainly colour-blind supports this conclusion.

Dr. E. N. Willmer said that, in spite of many attempts, colour vision had not been demonstrated in any mammal outside the primates. The primate stock was in all probability nocturnal in habits, with a retina dominated by rods, a rod being defined as a visual receptor cell containing rhodopsin and being maximally sensitive at 500 μμ. A cone contains a pigment other than rhodopsin and is maximally sensitive at 570 μμ. Histologically, although they are typically very different, they may in certain species and situations be difficult to distinguish. Moreover, rods themselves may differ widely in their power to accumulate rhodopsin, and Granit has demonstrated the existence of distinguishable groups of high- and low-threshold rods in cats and guinea pigs. It is probable that, in view of their evolutionary history, the mechanism of colour vision in mammals may be quite different from that of birds, which is probably wholly dependent on cones. Dr. Willmer said he would submit evidence that in primates colour vision depends on rods and cones; neither alone can produce the sensation of colour.

In the colour vision of primates, the most important part of the retina is the central part of the *macula lutea*, which is called the *fovea*, and subtends an angle of about 2°. Within the fovea is the central 'rod-free' area subtending less than 1°, with greatly diminished power of dark-adaptation and containing no low-threshold rods. The normal fovea in man is trichromatic and must contain at least three types of receptor elements with separate pathways to the colour-analysing centre of the brain. The rod-free area, however, behaves as a dichromatic system. Within it all spectral colours can be matched by mixtures of red and violet.

Subjects who confuse red and green (both protanopes and deuteranopes) are completely colour-blind in the rod-free area. Any spectral hue can here be matched to any other by altering its intensity only. They differ, however, in the spectral sensitivity of this area, protanopes being relatively insensitive to red and deuteranopes falling into two classes, normal (type I) and relatively insensitive to blue (type II), respectively. It is inferred that the sensitivity curves of the protanope and the deuteranope (type II) represent respectively the spectral sensitivity of the two elements normally present in the rod-free area. For the deuteranope (type II) the inference is strongly supported by the way in which the thresholds for red and violet light respectively are modified by previous exposure to high intensities of red or violet. The deuteranope of type I has normal sensitivity and adaptation, indicating that both 'red' and 'green' receptors are present in the central rod-free area; but he is colour-blind because their output is not recognized as distinct by the central analyser. The deuteranope (type II) is colour-blind in the central fovea because only the 'red' receptors are present. Further, the sensitivity curve of the 'red' receptors is not so unlike the absorption spectrum of iodopsin as to exclude the idea that the 'red' receptors are, in fact, cones in which iodopsin is the sensitive pigment. In spite of certain complications in the adaptation results, it is probable that the protanope is colour-blind in the rod-free area because only 'green' receptors are present.

Histologically, two trends are distinguishable in the evolution of the primate retina: the specialization of the rod + mop-bipolar system for dim-light vision and of the cone + midget bipolar in the centre of the retina for good acuity at higher illumination. These lead ultimately to the existence of three pathways in the eye as a whole and two in the central fovea. The pathways are formed by the mop-bipolars relaying from low-threshold rods (the 'blue' pathway), the flat bipolars relaying from high-threshold rods and cones (the 'green' pathway), and the midget bipolars relaying from cones only (the 'red' pathway).

Both histological evidence of the evolution of the retina in primates and the evidence from the examination of colour-defect in man, Dr. Willmer said, are consistent with the existence of three types of receptor only, namely, cones, high-threshold rods and low-threshold rods, the two first only being present in the 'rod-free' area.

Admiral T. P. H. Beamish stressed the continuing importance for the Services of research on colour vision, relating that his own yeoman of signals had been found to be colour-blind after thirteen years of service. Dr. L. C. Thomson pointed out that Dr. Willmer was relying heavily on the fact that protanopes are totally colour-blind in the rod-free area. In Dr. Thomson's experience, this was not altogether true and a time factor was involved. The subject is conscious of a colour sensation initially, which changes or vanishes on continued fixation.

Dr. H. J. A. Dartnall raised the question whether the absorption spectrum of iodopsin is sufficiently close to the sensitivity curve of the deuteranope, type II, to justify the assumption that human cones depend on iodopsin.

Prof. H. Hartridge said that he could confirm the old observation of Holmgren that a bright yellow point centrally fixated could be seen as red, white, green or yellow and a blue point as green, white, blue or violet. How was it possible to reconcile this observation with the existence of only two receptor types in the central fovea ?

Dr. M. H. L. Pirenne suggested that more use might be made of the opto-motor reaction in investigating the colour-vision of animals by a method similar to that used by Hecht in determining acuity.

Dr. Willmer, in reply to Dr. Thomson and Prof. Hartridge, said that it was not really relevant to argue about whether or not a colour sensation was aroused in the subject. The crucial question was whether the sensation, whatever its subjective nature, could be matched tri-, di- or mono-chromatically.

Dr. Pumphrey, in reply to Dr. Pirenne, said that the difficulties of the technique suggested, if not insuperable, were so formidable that suspicion might attach to the results. The method had, in fact, been tried by Birukow on the frog with results in conflict with those of other workers. R. J. P.

PHYSICAL AND PSYCHO-PHYSIOLOGICAL ASPECTS OF COLOUR

THE British Psychological Society and the Colour Group of the Physical Society held a joint meeting, their first, in the Hastings Hall, Tavistock House, London, on February 12, when a number of problems about colour were discussed. Mr. J. G. Holmes, chairman of the Colour Group, was in the chair. Three main topics were introduced by members of a panel consisting of Dr. L. C. Thomson (Vision Research Unit, Medical Research Council), Mr. R. C. Oldfield (Institute of Experimental Psychology, Oxford), Dr. R. W. Pickford (Department of Psychology, Glasgow), Dr. W. D. Wright (Department of Optics, Imperial College of Science and Technology, London) and Mr. W. A. Allen (Building Research Station, Department of Scientific and Industrial Research). General discussion of each subject followed the contributions of the panel.

Dr. Thomson spoke first, on "The Measurement and Meaning of the Luminosity Curve". He emphasized the difficulties of determining accurately the forms of this curve, and outlined the two principal methods, namely, (*a*) obtaining brightness matches for a series of monochromatic stimuli against a standard monochromatic stimulus; (*b*) determining the absolute intensity-threshold for a series of wavelengths. By these methods the photopic and scotopic curves are obtained, and their form and relative position in the spectrum suggest a number of problems, of which Dr. Thomson detailed two. The first of these is that of the shift in the position of the luminosity curve as conditions are changed from scotopic to photopic, and in this connexion he made reference to Dartnall's suggestion that such a shift might be produced by selective absorption by increasing concentrations of the breakdown product of rhodopsin—indicator yellow—under increasing light intensities. Such a hypothesis would, he remarked, predict a limited shift of about the correct amount. The second problem about the luminosity curves raised by Dr. Thomson was that of the secondary maxima, or 'humps' found on the photopic curve. He pointed out that if these are connected with independent colour mechanisms, doubts must arise regarding that part of the Young–Helmholtz trichromatic theory which postulates that a sensation of white is the product of the activity of the three colour receptors alone, and of no other mechanism.

Mr. Oldfield referred briefly to some of the problems, physical and psychological, which arise concerning the position of the luminosity curve in the electromagnetic spectrum, and the biological utility of colour vision. He cited Wall's view that, since the vertebrate eye evolved in an aqueous environment, the absorption spectrum of water must be one of the factors determining the position and extent of the sensitivity curve of the eye. He mentioned other physical factors which impose similar limitations. On the question of the biological utility of colour vision, he referred to the difficulties of determining accurately its incidence among animal species, and remarked upon its somewhat odd occurrence. He suggested that its chief utility lies in the enormous variety of discriminable patterns of visual stimulation that it affords, compared to the resources offered by mere intensity discrimination. He asked whether the actual incidence of colour mechanisms might not be bound up with the food habits of the species concerned.

Dr. Pickford spoke next on "The Inadequacy of Existing Tests of Colour Vision". He remarked first that most tests are vitiated by the fact that they were devised with a theory of colour defect in mind. Indeed, he said, most would be quite useless if the phenomena of colour-blindness did not show marked discontinuities. The tests are satisfactory only in so far as they are responsive to distinctions between the colour-blind and the normal. They have little capacity to separate out the anomalies. He then briefly criticized a number of tests in common use. Holmgren's wool-test had been effectively disposed of by Edridge-Green, who showed that it failed in many cases to detect defects of occupational significance. Tests of the Stilling and Ishi-Hara type serve to reveal the chief discontinuous classes of colour defect, but scarcely do much to distinguish the protanope from the deuteranope. Edridge-Green's bead test depends on naming, and no test should depend on this alone; further, its yellow-blue section is ineffective, and the test generally is too easily passed by defectives. Lantern tests such as those of Edridge-Green and Martin depend on naming, itself a complex function. They also suffer from extreme intricacy of procedure, if the instructions are fully complied with. Spectrometer tests, again, rely on the expression of discrimination in terms of names, and suffer from the disadvantage that they require an experienced worker to administer them. They are also unable to deal with the red-green anomalies. The anomaloscope, finally, is excellent for the detection and measurement of red-green anomalies, but is unsuitable for use on other types of defect.

Dr. Wright maintained that the available tests are not entirely unsatisfactory, provided they are used for purposes to which they are suited. In occupational testing it is important in the first place to pick out the grosser defects, and to select those subjects who require further testing of a more special character. The Ishi-Hara test and the anomaloscope together will achieve this. The more special tests should be devised so as to provide as close an imitation of the occupational working conditions as possible. Dr. Wright emphasized that, as an occu-

pational problem, colour-blindness cannot be treated in terms of discontinuities. The appropriate borderline must be fixed in the light of each type of occupational requirement and circumstance. For the scientific investigation of colour defect, all that is required of the tests is that they should be able to pick out with reasonable reliability those individuals requiring more intense study by specialized laboratory methods. Existing tests such as the Ishi-Hara satisfy this requirement.

The discussion was then thrown open to the meeting, and a number of members took part. Several commented on the usefulness of the Ishi-Hara test in examining school-children, and the view was expressed that, if used in suitably defined and standardized conditions, especially as regards illumination, the test is an effective one. Some discussion took place on the relationship of intelligence to colour-vision test performance; and the implications of supernormal colour discrimination were briefly examined, together with the part played by training and practice. A number of remarks were also made concerning the conditions and significance of binocular chromatic fusion.

Mr. Allen then spoke on "The Effect of Colourful Decoration and Lighting". He explained that these problems, which are of great importance to the architect, builder, and industrial manager, fall into two types. In the first place, colour effects can be used in factories and other places of work to promote, through broadly æsthetic channels, cheerful and pleasant states of mind conducive to efficient work and the avoidance of fatigue. In the second, there are more specific problems of promoting physiological well-being by such factors as the avoidance of glare, the production of a feeling of warmth, and so forth. The first, more æsthetic, group of effects allows considerable latitude in the choice of suitable colour schemes. But in the case of the second, choice is dictated by the particular problems to be solved. Mr. Allen gave examples in which such choice had been successfully made. In one case lighting conditions, and particularly the absence of glare, in recently built schools caused the teachers to insist that they felt markedly less strain in their work, while the children showed a smaller tendency to somnolence in the afternoons. Mr. Allen concluded by remarking that what had hitherto been done towards a solution of these problems had been upon a somewhat intuitive and *ad hoc* basis, and he appealed for an attempt to be made towards a scientific formulation of the necessary principles.

In the course of the subsequent discussion, attention was directed to the difficulties of investigation in this field. Mr. Oldfield emphasized the danger of drawing conclusions from short-term experiments. At the same time, he said, there is a natural hesitancy in embarking on long-term investigations involving great expenditure of time and effort where so little is known of the individual factors that may play a part. Mr. H. D. Murray expressed himself as disappointed with what the psychologists had at present to offer. He had hoped that some relatively simple indicator of the effect of these factors might be devised, though he acknowledged that those commonly used, such as output, minor accident-rates, etc., in investigation of the effects of more specific environmental conditions were inappropriate in this field. He said that any good suggestions, even if they afforded only partial solutions, would be very welcome to people in industry.

The chairman, in both his opening and closing remarks, stressed the importance of bringing psychologists, physicists and physiologists together for the common discussion of the problems of colour. He was sure, he said, that such contacts would be very fruitful in suggesting valuable and novel experiments.

R. C. Oldfield

THE ROYAL INSTITUTION AND SCIENTIFIC RESEARCH*

By Prof. E. K. RIDEAL, O.B.E., F.R.S.

THE free and unfettered pursuit of knowledge which Rumford and Davy laid down as the object of the Royal Institution has had surprising results. This is not the place to catalogue the vast list of scientific discoveries which have emanated from the laboratories and desks in this building from the time of Rumford to the time of Dale. We usually associate the names of workers in science with some particular achievement, because that particular piece of work has had a great influence either on modern philosophical thought, or on some modern branch of experimental or theoretical science, or again, in some field of technological endeavour; but their other and less-known achievements in different fields are not to be ignored.

The spirit of freedom and of inquiry is like the wind which bloweth whithersoever it listeth, and it may be of interest to examine the contributions which workers in the Royal Institution have made to the subject of the physics and chemistry of surfaces and colloids, a field in which the laboratory is especially interested at the present time, and to compare the methods of experimental approach adopted by them with those now current.

We usually associate the name of Count Rumford himself with the concept of the mechanical equivalent of heat; but we find that he was interested in surface tension, and held several classes on the subject. In a similar manner, Davy, associated by us with the discovery of the alkali metals by electrolysis, the definition of acidity and the physiological effects of nitrous oxide, was interested in the movement of crystals of potassium acetate on the surface of water, and remarked that their lively motion was retarded by a layer of oil.

Observing that small solid objects could float on a water surface and that it was generally attributed to air adhering to the surface, Rumford devised experiments to prove this was not the case. One simple experiment consisted in allowing a needle to fall on a water surface under ether, when the needle remained suspended at the ether–oil interface. He concluded that the particles of water adhere strongly to each other, forming, in consequence, a kind of pellicle at the upper surface. With this concept he interpreted the concavity of a water surface confined in a small vessel, the suspension of water in a capillary tube and the like. He inquired as to the form of the sessile drop and noted that the resulting film at the surface must be extremely thin.

Rumford observed that Laplace's attractive forces in that writer's theory of surface tension are to be identified with his adhesional forces. He commented on the great author of "Mécanique Céleste" as follows: "I must confess that I am not sufficiently

* From a Friday Evening Discourse at the Royal Institution on March 4, in commemoration of its foundation on March 7, 1799.

well versed in higher geometry to understand fully the calculations of M. Laplace on this subject, and I shall take good care not to pass judgment on them . . . but I have such a high opinion of the talents of this man, that I am always inclined to receive his opinion in matters of science, as well as on every other subject, with the greatest deference".

It was doubtless Rumford's and Davy's work on surface tension that led Thomas Young to develop his well-known theory of cohesion and capillarity, which was singularly successful. Young was the first to deduce an estimate of molecular dimensions from data provided by that theory, to define exactly what is meant by the angle of contact, and interestingly enough, he examined the variation of that angle for metals amalgamated with mercury. He calculated the range of the cohesive forces to be 4×10^{-9} in., or one Angström. He developed the drop-weight method of measuring surface tension and took issue with Laplace on the origin of the surface forces, knowing, indeed, that repulsive, as well as attractive, forces were involved.

It is scarcely necessary to mention the contribution of Lord Rayleigh to the subject of surface tension—his method of measuring dynamic tension, which is now universal, and his estimation of the size of molecules by using Davy's experiment to determine the amount of oil required to stop the movements of camphor. He also investigated the theory of surface forces and showed how the theories of Laplace and of Young had to be supplemented by Gauss's hypothesis of surface potential-energy. Experimentally, he achieved a triumph in describing how he succeeded in spreading water on clean mercury.

Dewar examined the properties of soap films in detail, revealing their laminated structure and determining many properties such as their permeability to gases.

Another interesting phase of surface chemistry and physics is to be observed in the development of our ideas of heterogeneous catalytic action. Davy in his experiments on the miner's safety lamp showed that neither flame nor explosions would pass along narrow metallic tubes. In the case of explosions, we can understand the breaking of the wave front by the tube systems; but in the propagation of flame two factors have to be considered, namely, the loss of heat in the walls, and the catalytic activity of the walls. We now have evidence that in a number of cases in the propagation of flame there is an advancing front of free radicals and of hydrogen atoms. The power of metals to combine hydrogen atoms catalytically can be demonstrated in many ways. We may note that in Faraday's experiments on electrolysis the hydrogen atoms liberated at the electrode combine and come off as molecules, especially noticeable on platinum, where the over-potential is low. Later, the fact that the expected volumes of electrolytic gas were not always obtained led Faraday to his important investigation on the power of metals to induce the combination of gases. He propounded a theory of catalytic action which still has many protagonists. He regarded the gases as condensed on the surface by what we now call Van der Waals's or dispersive forces, a type of condensation used later by Sir James Dewar in utilizing cool charcoal for obtaining high vacua.

Faraday writes in his notebook, November 25, 1833, "Think this (surface adsorption) a subject of great consequence, for I am convinced that the superficial actions of matter and the actions of particles not directly or strongly in combination are becoming daily more and more important in chemical as well as in mechanical philosophy". Again, "Immerse the blade of a knife in water, on drawing it out it will not be equally wet, but the water will appear in particles or run into globules. But suppose you dip in the platina plate cleaned as directed, it comes out uniformly wet."

It is now possible to examine the primary products of catalytic actions by means of the mass spectrograph, one of which has been made in the Institution and is in use for this purpose. It was in the lecture theatre of the Institution that Sir J. J. Thomson gave the first account of his discoveries concerning the parabolas described by positive ions in a field, an effect from which Aston developed the mass spectrograph.

Surface chemical reaction was noted by Rumford, who showed that a pellicle of gold would develop at the interface between a gold chloride solution and ether, or on an impregnated carbon disk, on illumination; and Faraday carried out similar experiments. We now have a more sensitive method of measuring these reactions at liquid surfaces by means of the phase boundary potential changes caused in chemical reaction.

In another field, I would like to refer to the light-scattering experiments of Tyndall, and the theoretical examinations by Lord Rayleigh which have led directly to the modern method of measuring the size of colloid particles, especially developed by Debye.

The work of Sir William Bragg on X-rays has led to the possibility of examining colloidal material by this method. It is possible from the X-ray spacings of solutions to obtain some of the dimensions of colloid particles such as the molecule of ovalbumin.

The subject of the physics and chemistry of surfaces, although only a small brick in the great edifice of science, yet contains within itself many interesting and wonderful things, and our present knowledge of what is sometimes regarded as a very recent development is, indeed, part of the heritage into which we enter when we work in the Royal Institution and in its Davy Faraday Laboratory.

It will not be denied that the Institution of Rumford and of Davy has not only pursued the objectives which the creators desired, but also has contributed continuously to the advancement of knowledge. We must now ask ourselves the question whether an institution founded one hundred and fifty years ago has a place or function in the Britain of to-day and to-morrow.

During the last decade, we have witnessed the gradual disappearance of an individualistic society. This change has been reflected in many aspects of science. We note the growth of the concept of the planned mass attack on specific problems by the co-ordinated efforts of teams of workers. One does not venture even to guess at the number of scientific workers engaged on the Manhattan project or on penicillin. There is much to be said for such developments in a technological sphere, especially as we are living in a world of fast dwindling assets:

> But where shall wisdom be found?
> And where is the place of understanding?
> It cannot be gotten for gold
> Neither shall silver be weighed for the price thereof.
> Yea, the price of wisdom is above rubies.

In the exploration of uncharted seas which are lit by no beacon light, but illumined only by the inner light and imagination in the mind of the explorer, it is still, and must ever be, the individual. The characteristic, individualistic attitude of the workers in the Royal Institution can thus find a place in modern society. Indeed, if such places did not exist, we should have to create them in order not to lose our souls. How best to preserve its freedom of thought, and thus serve most effectively both science and the State, is an ever-recurring problem.

It is certain that Michael Faraday, whose name is most naturally associated with this Institution, would be the first to object to its conversion into a museum to perpetuate his memory. He would, we feel sure, prefer to see it as a live and active centre of research. Indeed, he could have no better memorial than a laboratory to which people interested in Nature and with inquiring minds could work. Some idea such as this must have entered the mind of Ludwig Mond, when he conveyed in 1896 the Davy Faraday Research Laboratory to the Royal Institution.

To solve this problem in all its functional and economic aspects, there is still much to do, and we of this generation must see to it that we do not, in spite of difficulties, fail to give an account of our service and stewardship.

I cannot do better than terminate with the words of Sir Humphry Davy :

"Let not the countrymen of Bacon, of Newton and of Boyle neglect those pure springs of knowledge from which these great men drew such copious supplies both for profit and for glory, and let it not be forgotten that science has its moral and intellectual, as well as its common aims, and its object is not only to apply the different substances in nature for the advantage, comfort and benefit of man, but likewise to set forth that wonderful and magnificent history of wisdom and intelligence which is written in legible characters both in the heavens and on earth."

OBITUARIES

Prof. T. S. Patterson

THOMAS STEWART PATTERSON was born in Greenock in 1872. After his early education at Merchiston Castle School, of which in later years he became a governor, he studied chemistry at the Andersonian College, Glasgow, under Dittmar, and then proceeded to Heidelberg, where he graduated as Ph.D. in 1896 with a thesis on iodoso- and iodo-benzaldehyde. In this romantic city by the Neckar he fell under the spell of that man of genius, Victor Meyer, who was then at the height of his transcendent powers. After a year in Birmingham as the first Priestley scholar, he became a member of the staff of the Yorkshire College, Leeds, before he returned to Glasgow in 1904 as senior assistant to the professor of chemistry in the University, being afterwards promoted to Waltonian lecturer and lecturer in organic chemistry. He graduated as D.Sc. both in London and Glasgow, and in 1919 he became the first holder of the Gardiner chair of organic chemistry at Glasgow, which he occupied with distinction until his retirement in 1942. His services to the University were honoured by the conferment upon him of the degree of LL.D. in 1943. During his tenure of the chair he played his full share in administration, since he served for some years as dean of the Faculty of Science, and as a member of the University Court. The welfare of his students, with whom he was very popular, made at all times a great personal appeal to him, and he was one of the founders of the Alchemists' Club, which served so much to broaden their outlook.

It was one of the two pioneers of stereochemistry in Great Britain, namely, Prof. Percy Frankland, who attracted him to that particular branch which deals with the connexion between optical rotatory power and chemical constitution. His first paper on the effect of chloroacetyl groups on the rotation of methyl and ethyl glycerates and tartrates was published in 1898, and was followed by a long series of thirty-eight communications on the influence of solvents and other factors on the rotation of optically active compounds. Those researches, which were prosecuted in elaborate detail and with great regard for accuracy, displayed at once originality and experimental skill of a high order, and gained for him the reputation of being the leading authority on this fundamental theme. True it is that his early polarimetric measurements were confined to light of one wave-length only, and for that reason his deductions were occasionally somewhat lacking in conviction. But the valuable work of Pickard and Kenyon on optically active secondary alcohols attracted his attention to the necessity of extending his investigations to take account of results with lights of varying wave-lengths, while the usefulness of the characteristic diagram of Armstrong and Walker in correlating optical rotation data was also stressed. Even then, his results were occasionally difficult to interpret ; the problem at issue was indeed a most evasive one. It was accordingly understandable that discussions with workers in the same field, such as Walden, Lowry and Pope, assumed at times a somewhat acrimonious trend. Well indeed might Patterson have exclaimed with Alan Breck, "And O, man, am I no a bonny fighter ?"

Other topics investigated dealt with optical superposition, and with the polarimetric study of intramolecular re-arrangement. The latter topic yielded some interesting results. Thus, the *syn*- form of benzaldoxime was shown to have a much more pronounced effect on the numerical value for the rotation of a solution in ethyl (+) tartrate than had the corresponding *anti*-oxime, so that the velocity of re-arrangement could be observed with ease. While other compounds were shown to display a similar transformation, it was noted that the purer the ethyl tartrate the more slowly did the interchange occur. Reference might also be made to his 'green' ethyl tartrate. 'Back to Pasteur' was the note struck in his final experimental contributions with Buchanan on the crystalline forms of various sodium and potassium tartrates. It always gave Patterson pleasure to show visitors to his laboratory those large crystals where the hemihedral facets stood out so beautifully.

No account of Patterson's work would be complete without reference to his scholarly writings on the history of chemistry. Those included aspects of Helmont, Beguin and Leblanc ; most important was his elaborate critical survey of Mayow on respiration and combustion. In his later years he was more particularly interested in Paracelsus.

Patterson spent his vacations mainly on the Firth of Clyde, for he was an expert yachtsman, and a member of the Clyde Corinthian Club. His death on February 14 of this year will have recalled to his many friends the memory of a very upright and lovable man.

ALEX. MCKENZIE

Mr. Birrell Russell

On March 4, after making an adjustment at the top of the apparatus on which he was working, Birrell Russell slipped in some unexplained way and fell 33 ft. to the ground. He received very severe head injuries and died without regaining consciousness in the early morning of March 8.

Russell was a senior member of the staff of the Atomic Energy Research Establishment, Harwell, having been promoted to principal scientific officer in 1947. He graduated at Glasgow in 1933, taking first-class honours in mathematics and natural philosophy (second place for the year). He then did two years research work, as Houldsworth Research Scholar, on the diffraction of proton beams. From there, he went to the National Physical Laboratory, taking up radio research, and was transferred in 1937 to the Royal Aircraft Establishment, where he worked under Dr. A. C. Bartlett on very high frequency radio for aircraft. In 1940, he was moved to the Telecommunications Research Establishment, then at Worth Matravers, and remained with that Establishment throughout the War.

Russell's work at the Telecommunications Research Establishment was mainly on aerials for aircraft radar. He worked first on aerials for the early version of A.I., the radar device used by fighters to track down enemy aircraft in the dark. Later, he devised direction-finder aerials to enable our long-range fighters to home on to enemy fighters fitted with A.I. Thus he was able to develop a device which enabled our fighters to single out and destroy enemy night-fighters. This was put into operational use with excellent results in the British large-scale bombing offensive. At the end of the War, Russell worked on centimetre-wave aerials and was the author (or part author) of two papers on this subject in the *Journal of the Institution of Electrical Engineers*.

In the summer of 1946, Russell transferred to Harwell, where he was one of the first residents on the site. He was set the problem of isotope separation by the method of gaseous thermal diffusion. As a result of his work, he was able to set up a plant for the production of oxygen-18, enriched from its normal concentration in atmospheric oxygen up to about 20 per cent. This plant had been erected and tested, and was due to start production on March 7. The product was to be sent to the Medical Research Council for use as a non-radioactive tracer in important medical and biological work. It was after making a final adjustment to a water relay in preparation for the production run that the accident occurred.

Russell had considerable experience in the supervision of the work of junior staff and was in charge of a group working on various problems connected with isotope separation in the gas phase. He was a very energetic and capable experimentalist who had his heart in his work, and Harwell and the world of science generally have suffered a severe loss in his premature death. He leaves a widow and two small children.

H. W. B. Skinner

We regret to announce the following deaths:

Sir Thomas Hill Easterfield, K.B.E., during 1899–1919 professor of chemistry in the Victoria University College, Wellington, New Zealand, and director during 1919–33 of the Cawthron Institute, on March 1, aged eighty-two.

Sir William Hale-White, K.B.E., of Guy's Hospital, London, president in 1922–23 of the Royal Society of Medicine, on February 26, aged ninety-one.

Mr. James Hornell, known for his studies of primitive boats, on February 24, aged eighty-three.

Sir Archibald Page, formerly chairman of the Central Electricity Board, and president in 1927–28, and honorary member, of the Institution of Electrical Engineers, on March 7, aged seventy-three.

NEWS and VIEWS

Agricultural Research Council: Dr. W. K. Slater

With the approval of the Lord President of the Council and after consultation with the president of the Royal Society, the Agricultural Research Council has appointed Dr. W. K. Slater to be its secretary, in succession to the late Sir John Fryer, as from May 1. The Minister of Agriculture and Fisheries has agreed at the request of the Agricultural Research Council to release Dr. Slater from his present duties as a senior education and advisory officer in the National Agricultural Advisory Service. Dr. Slater was educated at the Oldham Hulme Grammar School and at the University of Manchester, where he graduated in 1914. In 1922 he joined the team working under Prof. A. V. Hill in the Department of Physiology, Manchester, and later followed Prof. Hill to University College, London. During the next six years, Dr. Slater held Junior and Senior Beit Memorial Medical Research Fellowships, and carried out a series of investigations on the anaerobic phase in muscular contraction and on the general phenomenon of anaerobiosis in animals. In 1928 Dr. Slater joined the staff of the Dartington Hall Trustees to set up a research laboratory and supervise the scientific aspects of their wide-scale experiments in rural economy, and later he was placed in charge of the administration of the agricultural departments of the Trust. Although personal research work was not possible, the laboratory at Dartington Hall under Dr. Slater's general supervision co-operated extensively with the research institutes on a wide range of problems, and did valuable work on the control of potato blight and on cobalt deficiency effects in sheep. In 1942 his services were loaned to the Ministry of Agriculture and Fisheries to assist the late Sir John Fryer in connexion with the Agricultural Improvement Council, and when Sir John became secretary of the Agricultural Research Council, Dr. Slater followed him as secretary of the Agricultural Improvement Council.

J. W. Döbereiner (1780–1849)

Born at Hof in Bavaria, Johann Wolfgang Döbereiner began as a pharmacist's apprentice in 1794, and later practised pharmacy at Dillingburg, Karlsruhe and Strasbourg, where he set up as a manufacturer of chemicals. For a time he conducted an institute for teaching practical chemistry; then he joined a textile company and set about improving dyeing processes. The Napoleonic wars ruined him; but he was fortunate to come to the notice of Goethe, who obtained for him a professorship at Jena, where

he remained from 1810 until he died on March 24, 1849. Döbereiner is credited with improving (and giving a correct explanation of) the making of vinegar; but he is best known for directing attention, in 1817, to the fact that the atomic weight of strontium is the mean of those of calcium and barium. He also noticed the same relationship with other 'triads' (chlorine, bromine, iodine; sulphur, selenium, tellurium). Döbereiner's 'triads' passed unnoticed at the time, and only after Newlands' 'law of octaves' and Mendeléef's Periodic Law had been enunciated some fifty years later did Döbereiner's work attract attention. It is also not generally known that he introduced, in 1832, the method of preparing oxygen from potassium chlorate by heating in the presence of manganese dioxide.

Government Grants for Research and Development

In the Supplementary Civil Estimates for the year ending March 31, 1949, aggregating £221,471,574, there are various sums for scientific research and like purposes in Great Britain. The additional £1,950,000 for development and welfare (Colonies, etc.) includes a further £450,000 for research schemes, making a total for the year of £750,000. An additional Treasury grant-in-aid of £600,000 is required to meet liabilities maturing in respect of capital grants already approved to the Universities and Colleges of Great Britain. Of the additional £152,000 gross for the Department of Scientific and Industrial Research, £86,000 is required for grants to students and others engaged in scientific research, £5,000 for grants to research associations and other bodies engaged in industrial research to match increased industrial contributions, £34,000 for extra-departmental research work, £16,000 against salary revision and £11,000 for salary revision at the Geological Survey of Great Britain and the Museum of Practical Geology. Appropriations-in-aid and certain anticipated savings reduce the supplementary estimate to £81,000 net. The Ministry of Supply requires a further £1,760,000 net for research and development, of which £360,000 is for research and development work carried out by industry, and £2,150,000 gross for plant, equipment, stores and materials for Government establishments. Among miscellaneous items are grants-in-aid of £6,000 for the Institute of Public Administration, £12,000 for the Imperial Institute, £20,000 for the British Institute of Management and £25,000 to the Council of Industrial Design for preparatory work for the Festival of Britain, these last falling under the Board of Trade vote. The supplementary estimate for the Scottish Home Department includes a grant-in-aid of £20,000 for the National Trust for Scotland.

Human Skull from Fontéchevade, France

Two years ago it was reported that part of a human skull had been discovered at Fontéchevade in the Charente district of France. The importance of this discovery is related to its antiquity, for according to the preliminary account it was found in association with implements of Tayacian type and with remains of the 'warm' fauna which preceded the Würm glaciation. The skull, therefore, appears to antedate Neanderthal man and to represent the most ancient human remains (stratigraphically well documented) so far discovered in France. A note on the specimen by H. V. Vallois has recently appeared in *Comptes Rendus* of the Paris Academy of Sciences (February 14). Unfortunately this note is very brief, and is illustrated by only one outline drawing of the lateral view of the skull. The latter consists of the greater part of the parietal bones and approximately the upper two-thirds of the frontal. These bones are unusually thick, and in this feature are comparable to the Swanscombe skull (which dates from the middle Acheulean period). It appears also that, so far as some of their main characters are concerned, they show no evidence of Neanderthal affinities. The supra-orbital part of the frontal bone is unfortunately missing; but the position of the upper margin of the frontal air sinus is indicated, and from this it appears certain that the curvature of the forehead region of the skull must have conformed closely to that of *Homo sapiens*. In other words, there is no evidence of a heavy supra-orbital torus of Neanderthal type. So far as this rather meagre evidence goes, the Fontéchevade skull confirms the evidence of the Swanscombe skull from the Thames valley that Neanderthal man was antedated in Europe by a type of man which approximated in cranial characters more closely to *Homo sapiens*. It is to be hoped that a full and well-illustrated account of the Fontéchevade skull will not be long delayed.

Significance of Complementarity in Physics: *Dialectica*

The word 'complementarity' was originally introduced by Niels Bohr to express one of the most fundamental ideas in quantum theory, that we cannot simultaneously measure both the position and velocity of a particle—the more we know about one, the less we can know about the other. It is in this sense that we speak of our knowledge of the two quantities as complementary. But the idea is capable of wide generalization, since position and velocity (or momentum) are not the only pairs of 'conjugate observables'. Indeed, it is no exaggeration to say that a proper understanding of this principle is the greatest single contribution of modern physics to philosophy. The editorial board of *Dialectica*, a quarterly journal devoted to a review of the philosophy of knowledge, has done a public service by assigning the whole of the current issue (vol. 2, No. 3–4, published in Neuchâtel, priced 4.80 Swiss francs and obtainable from H. K. Lewis, 136 Gower Street, London, W.C.1) to a study of the single topic of complementarity.

The present issue is the more remarkable because no less than five Nobel prizewinners contribute to it. Pauli writes the editorial and briefly reviews the various subsequent contributions; Bohr describes the idea itself; de Broglie shows how it relates to the distinction between a complete unit (for example, a helium atom) and the individuality of its component parts (for example, electrons and nucleus); Heisenberg, to whom, of course, we owe the precise formulation of the uncertainty relations which lie at the heart of the idea, describes the progressive development of the concept; and Einstein restates one of his earlier arguments that present quantum theory is incomplete and requires to be supplemented, or replaced, by a new theory in which the state of any physical system is independent of any possible observations which might be made on it. Applications of the idea itself in the fields of biology and thought processes, and a possible way round some of the acknowledged difficulties in present-day quantum theory by the use of a non-Aristotelian three-valued logic in which statements may be either true, false or indeterminate, make up a most interesting volume.

Archiv für Meteorologie, Geophysik und Bioklimatologie

A NEW Austrian journal, *Archiv für Meteorologie, Geophysik und Bioklimatologie*, began publication last September under the editorship of Dr. W. Mörikofer (Davos) and Prof. F. Steinhauser (Vienna). It is divided into two series, (*A*) meteorology and geophysics, and (*B*) general and biological climatology (including their agricultural and micro aspects) and radiation phenomena. The issues will be of variable size, published (not at regular times) according to the material available; they will be combined into (probably annual) volumes each of about 400 pages. One part of each series appeared in September, (*A*) of 141 pages, price £1 5*s*. 6*d*., and (*B*) of 114 pages, price £1 3*s*. 0*d*. The first issue of series *A* contains seven articles and one note, all in German, but with abstracts in English (not always grammatical) and French. The authors are Courvoisler (barometric pressure variations), Defant (internal tidal waves), Reuter (heat balance of snow cover), Burkard (arctic ionosphere), Bouët (pluviology), Eckel (energetics of water-mixing), Toperczer (methodicity of land magnetic surveying), and Götz (note on auroral photography). The paper and printing are up to the known high standard of the publishing firm of Springer (now in Vienna), but an annoying and unnecessary inconvenience and waste of time are imposed on the reader by the fact that the pages are uncut; this practice has long been abandoned by many publishers, and it is difficult to see why any should continue it.

Journal of Geophysical Research

FROM March 1949 the journal *Terrestrial Magnetism and Atmospheric Electricity* will appear under the new title *Journal of Geophysical Research*. The change of name marks the transfer of editorship from Dr. J. A. Fleming to Dr. Merle A. Tuve, who is also a successor of Dr. Fleming in his other former capacity as director of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington. Dr. Fleming, who has been associated with the journal almost since its inception by L. A. Bauer in 1896, becomes honorary editor; the journal, aided by a subsidy (which will be continued and somewhat increased) from the Carnegie Institution of Washington, was published on Dr. Fleming's own financial responsibility for more than twenty years, and he gave to it generously also of his time and effort. It is hoped that other organisations, both national and international, will assist the journal financially in future, and that, with the aid of a page charge in cases where contributors' papers are sponsored by institutions, it will be possible, despite the great increase in costs, to continue to publish the journal at the very moderate subscription-rate hitherto charged, namely, 3 dollars 50 cents for the four numbers per year. The change of title indicates a widening of the scope of the journal, though the scope has long transcended the limits implied by the title now discontinued. All who know the journal in its old form will wish it success under its new title and auspices.

Indian Association for the Cultivation of Science

THE annual report for the year 1947–48 of the Indian Association for the Cultivation of Science covers the year ending March 31, 1948, and in addition to the usual financial statement and balance sheet there are appended lists of books added to the library during the year, periodicals received by subscription or exchange, members of the Council and of the Committee of Management and a report on the scientific work of the Association. In the latter Prof. K. Banerjee reports on R. K. Sen's continued study of the extra Laue reflexions of bensil, while over-exposed Laue photographs of pyrene have been taken by M. N. Dutta at 30–100° C. which show that the intensities invariably increase with temperature for all the different spots. M. Ganguly has found that very clear reflexions of the low-angle scattered X-radiation can be obtained by a crystal which is very slightly mis-set from the position for reflecting the direct beam. B. S. Basak has undertaken the complete determination of the structure of phenanthrene crystals by the Fourier analysis method, and, with A. K. Rai Choudhury, has made X-ray diffraction studies of beryllium – aluminium and tin – aluminium systems. X-ray studies of samples of Indian coals have been made by N. N. Gupta, and the mechanism of the formation of jutellite, a plastic from jute waste, is being studied by J. C. Maitra. B. K. Banerjee has continued to study the dispersion of metals and salts in glass, and Dr. A. Bose has undertaken a systematic investigation of crystal paramagnetism to determine whether group structure formed by the internal fields in the solid state persists in solution. A. Dutta has undertaken a systematic study of the magnetic and electric properties of semiconductors, such as tungstenite.

Prof. S. C. Sirkar reports on B. M. Bishui's investigation of the polarization of Raman lines of ethylene dibromide in various solvents and on his further work on the Raman spectra of 1 : 1-dichloroethane. The Department of Physical Chemistry only commenced work on October 1, 1947, but Prof. S. R. Palit reports that investigation has already been initiated on several problems in polymerization, on surface-active agents and metallic soaps in organic solvents with reference to solubility, surface tension, electrical and similar properties, on the kinetics of halogenation of sodium acetate in glacial acetic acid, sodium propionate in propionic acid, etc. Potentiometric studies in non-aqueous media have also been undertaken, as well as the synthesis of styrene, methyl methacrylate, etc., for high-polymer studies.

New York Academy of Medicine

Now that Great Britain is committed to the National Health Service, it is interesting to find that neither the retiring president of the New York Academy of Medicine, nor its incoming president, nor the Academy itself, can support, at present at any rate, compulsory national medical insurance in the United States. Dr. George Baehr, the retiring president, referred, in his valedictory address to the Academy delivered on January 6 last, to the report, published in 1947, of the four-year study made by the Academy's Committee on "Medicine and the Changing Order". He reminded his audience that the Academy recognizes the need for changes; but, after serious consideration, has decided definitely to oppose compulsory national medical insurance at the present time. Instead, it considers that a medical service with prepayment of fees can be attained more efficiently and with much less risk by Federal grants to State and local areas; such a service would be adaptable to the varying needs of the States and their political subdivisions and also to rural and urban areas. The Academy favours voluntary efforts because they are more flexible and experimental; but

it should consider earnestly the effects upon medical practice, education and research of the modern pre-payment schemes. A new Committee of Medicine and the Changing Order has been appointed to consider this question. Dr. Baehr also referred to the success of the new (twelfth) Microbiological Section of the Academy and to the great services performed by the Library, which is one of the largest in the world.

Dr. B. P. Watson, the incoming president, has spent most of his life as a teacher and thus becomes the head of an educational institution devoted to the needs of the medical profession, the layman and the community as a whole. He reminded his audience that present-day medicine is the result of a slow process of evolution, in which the scientific approach to medicine has played a part since "the beginnings of recorded time". This evolution is the result of the interplay between research workers, reactionaries opposed to change, extremists who wish to proceed too quickly and the backbone of the profession, composed of steady, experimental thinkers who await the results of experiments and give the individual and the community the best that the profession can offer. Dr. Watson felt that any plans for a compulsory national health insurance that could be instituted now would lower the quality of medical care provided and would give the individual medical practitioner a task that he could not perform with satisfaction either to himself or to his patients. The Academy recognizes the need for improvement in the distribution of medical care, so that everyone can have it, but it pleads for continuing study and development, so that the best medical service and better teaching and research may result. In the course of his address, Dr. Watson discussed medical education, emphasizing, as the Goodenough Report on British Medical Schools has done, the teaching of principles, the integration of details learnt and the infusion into the teaching of more of the philosophical thought bequeathed to us by the past and nowadays "forgotten in the hectic pursuit of each newly-discovered fact".

Forestry in Uganda : Report for 1947

THE annual report of the Forest Department of Uganda Protectorate for the year ended December 31, 1947, has recently been published (Entebbe : Govt. Printer, 1948 ; price 2*s*. 6*d*.). This report of 49 pages commences, as a number of recent forest reports from Africa have done, by a declaration of Government forest policy, which is on the familiar lines that have often been referred to in *Nature* in connexion with forestry notes. The forest policy during 1947 was considerably implemented as the report shows ; it was to some extent the result of the Development Plan for Uganda put forward by Dr. E. B. Worthington which was approved by the Legislative Council during the year. This plan provided for the Forest Department receiving the sum of £205,500 to be spent in the ten years 1947–56 on expansion and development schemes, and this sum was to be in addition to the ordinary normal recurrent expenditure. As the amounts to be spent from this allocation for work only included soft-wood timber plantations, fuel planting-schemes, and research and investigation, hardwood-timber planting schemes apparently are to be covered by normal recurrent expenditure. This appears to be a pity, since it would seem that the indigenous hardwoods of Uganda may be neglected. Anti-malaria plantations were formed, at the request of the medical and health authorities, and the Department meant to clear-fell and replant them at intervals as an addition to the fuel supplies ; but the health authority has been against clear-felling, and the plantations will be managed on the selection felling basis. The reservation of more forest has been proceeding, but it is pointed out that the distribution of forest is not all that could be wished for, particularly in parts of the Eastern Province ; nor is it hoped to be able to make further reserves, and this leaves one with village forests as the alternative. It is noteworthy in this report that the importance of the savannah forest has now come to be understood. In fact, it is stated that the greater part of Uganda is covered by this type of forest growth, and it is from the savannah rather than from closed forest that the demands of people for forest produce are chiefly met. It is a welcome sign that the formerly neglected savannah or 'bush' is now coming into recognition and, even more, that it is to be classified as 'forest'.

Hormones and 'Drop' of Apple Fruits

THE abscission or dropping of apple and other fruits after fertilization is sometimes a valuable natural method of thinning the crop, but is often the source of much loss of fruit. L. C. Luckwill has studied the relation to this 'drop' of a hormone occurring in apple seeds (*J. Hort. Sci.*, **24**, No. 1, 32 ; June 1948). He devised a quantitative method of measuring the hormone extract by treatment of tomato ovaries (*ibid.*, 19) and was able to show that the appearance of the hormone in the seed coincided with cessation of the post-blossom drop. In the variety Beauty of Bath, the hormone appeared 25–30 days after petal-fall. Seeds of nearly ripe apples had little hormone, and its disappearance corresponded with the occurrence of pre-harvest dropping of the fruit. Moreover, seeds from 'June-drop' fruitlets of two other varieties contained much less hormone than those of fruits which remained on the tree. This hormone can be extracted from the seeds with boiling water, and though it stimulates the development of tomato ovaries, it does not appear to initiate fruit growth in the apple. It does, in fact, appear to be concerned chiefly with the control of fruit drop.

Markle Foundation Scholarships in Medicine

UNDER the plan begun in 1948 by the John and Mary R. Markle Foundation to assist qualified men and women wishing to remain in academic medicine, thirteen men of science have been awarded grants of 5,000 dollars a year, for five years, to maintain them in the medical schools of the United States and Canada in which they now hold faculty appointments. So far, twenty-nine such awards have been made. The thirteen new recipients, their fields of interest, and place of present appointment are as follow : Dr. Francis P. Chinard (University of California and Johns Hopkins), clinical chemistry and physiology, at Johns Hopkins University ; Dr. Don W. Fawcett (Harvard), microscopic anatomy, at Harvard Medical School ; Dr. Allan V. N. Goodyer (Yale), internal medicine and cardiovascular disease, at Yale University ; Dr. John B. Graham (Cornell), pathology, at the University of North Carolina ; Dr. John D. Green (Oxford), anatomy and physiology, at Wayne University College of Medicine ; Dr. George Watson James, III (Washington and Lee University), internal medicine and physiology, at the Medical College of Virginia ; Dr. Ralph Jones, jun. (West Virginia

University and University of Pennsylvania), clinical therapeutics, at the University of Pennsylvania; Dr. George E. Moore (University of Minnesota), surgery and onocology, at the University of Minnesota; Dr. C. Barber Mueller (University of Illinois and Washington University), surgery and biochemistry, at Washington University; Dr. George W. Schwert, jun. (University of Minnesota), physical biochemistry, at Duke University; Dr. Beverly T. Towery (Vanderbilt), internal medicine and endocrinology, at Vanderbilt University; Dr. W. Clarke Wescoe (Cornell), pharmacology, at Cornell University; Dr. Donald R. Wilson (Oxford and McGill), internal medicine and endocrinology, at the University of Alberta.

Scholarships in the United States for British Students

THE Colorado School of Mines is offering a scholarship to a male student from England for the academic year 1949–50. A separate offer is being made for Scotland. The scholarship is worth 425–475 dollars and is renewable for a maximum period of four years. Further particulars and application forms may be obtained from the Assistant Cultural Officer, U.S. Information Service, American Embassy, 5 Grosvenor Square, London, W.1, or from the secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1, with whom application forms must be lodged by May 1.

Harvard University announces that a fellowship, worth 2,000 dollars, provided by Mrs. Frank Knox in connexion with the Frank Knox Memorial Foundation, will be made available to enable a student from the British Isles to spend the academic year 1949–50 at Harvard. The fellowship is open to students of all stages; but preference will be given to candidates who have graduated or are about to graduate in Great Britain or Ireland. There is no form of application. Further particulars can be obtained from the Secretary, Association of Universities of the British Commonwealth; applications must be completed by April 9.

International Conference on Science Abstracting

AN International Conference on Science Abstracting is to be held by Unesco in Paris during June 20–25. All Unesco and United Nations Member States will be entitled to nominate three delegates. Representatives have also been invited from the specialized agencies of the United Nations and from the appropriate international organisations such as the International Scientific Unions, the International Federation for Documentation and the International Organisation for Standardization. It is expected that the directors and editors of many of the most important abstracting services will be present at the Conference. Unesco will be glad to receive applications from persons other than officially appointed representatives who wish to attend as observers. The purpose of the Conference will be: "to consider and take action to improve and develop abstracting services for the natural sciences, both pure and applied, and to consider methods of increasing their usefulness to scientists, with regard at the same time to the related problems of indexing and accessibility of the recorded publications".

The Physical Society: Seventy-fifth Anniversary Celebrations

THE celebration of the seventy-fifth anniversary of the Physical Society will take place on March 21. A conversazione will be held in the Royal Society's Rooms, Burlington House, Piccadilly, London, W.1, during 8–11 p.m., with the president, Prof. G. I. Finch, and Mrs. Finch as hosts. Admission is by ticket only. Earlier in the day, at 5 p.m., the Guthrie Lecture will be delivered by Prof. A. O. Rankine at the Royal Institution, 21 Albemarle Street, London, W.1, the subject being "Experimental Studies in Thermal Convection".

Announcements

MAJOR-GENERAL CYRIL LLOYD, director of Army Education, has been appointed administrative director of the Department of Technology of the City and Guilds of London Institute as from October 1, in succession to Lieut.-Colonel W. French.

A DAVID ANDERSON BERRY Silver-gilt Medal with a sum of £100 will be awarded in 1950 by the Royal Society of Edinburgh for work on the therapeutical effect of X-rays on human diseases. Applications (with copies of accomplished work) must be sent to the General Secretary of the Royal Society of Edinburgh, 22 George Street, Edinburgh, 2, by March 31, 1950.

THE Arnold Gerstenberg Studentship for 1950 is open to students in the University of Cambridge who have obtained honours in the Natural Sciences Tripos and who went into residence not earlier than 1944. The Studentship will be awarded for an essay which must be submitted before May 1, 1950; full details may be obtained from Mr. R. B. Braithwaite, King's College, Cambridge.

DR. K. C. EDWARDS, reader in geography, has been appointed professor of geography, and Dr. E. J. W. Barrington, reader in zoology, has been appointed professor of zoology in the University of Nottingham. Both these chairs have just been established.

THE British Institute of Management will hold the fifty-third in the 'Oxford' series of Management Conferences at Cliftonville during May 5–8. The form of the Conference has been altered, and the general purpose is to obtain a consensus of opinion among practising managers on certain fundamental and possibly controversial questions relating to the development of management, for the guidance of the Institute. Applications for tickets and all correspondence should be addressed to the Director, British Institute of Management, 17 Hill Street, London, W.1.

A BOOKLET entitled "The Tilgate Story" has been issued by Messrs. F. W. Berk and Co., Ltd., of Commonwealth House, 1–19 New Oxford Street, W.C.1. This deals in a general way with the firm's research work on soil sterilization, deficiencies of soil nutrients, mercurial seed dressings, mercurized turf sand for the control of moss, and other mercury and copper fungicides and insecticides.

Mathematical Tables and Other Aids to Computation is a quarterly journal which is published and subsidized by the U.S. National Research Council. Not only is it running at a loss, but also costs are rapidly mounting. A substantial increase in the number of subscribers is necessary in order to avoid either increasing the price or reducing the size of the journal. The subscription-rate is 4 dollars per year, and full details may be obtained from the National Research Council, 2101 Constitution Avenue, Washington 25, D.C. In Great Britain the rate is 25*s.*, and the agent is Scientific Computing Service, Ltd., 23 Bedford Square, London, W.C.1.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Heavy Nuclear Splinters

An extensive analysis[1] of the energetic disintegrations produced in the silver and bromine nuclei of nuclear emulsions exposed to cosmic radiation indicates that the emitted particles, consisting of α-particles, protons and neutrons, generally escape from the nucleus after the excitation energy has been statistically shared among the constituent nucleons.

The disintegration process is then analogous to the evaporation of molecules from a drop of liquid.

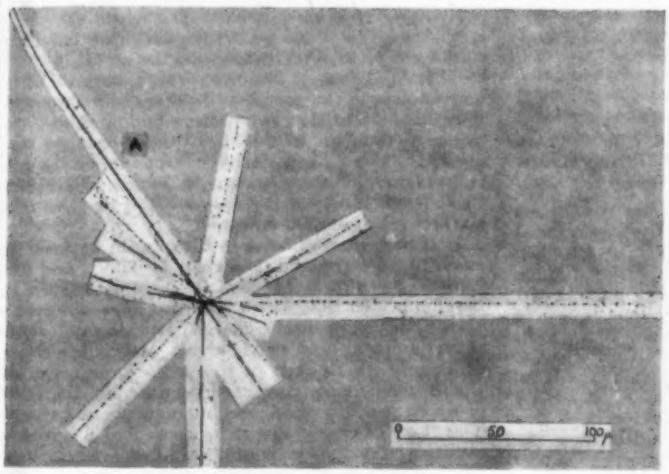


Fig. 1. Complete disintegration of a bromine nucleus, with emission of a heavy fragment of $Z = 11 \pm 1\ e$. Observer: Miss J. Steward

Occasionally, however, stars are observed[2-4] in which highly charged nuclear splinters are ejected from strongly excited nuclei before equilibrium has been attained. From a total of six thousand stars, we have observed two examples in which we can identify such heavy fragments. These events are not so rare as this might imply, since their tracks can only be identified when they have a considerable length in the emulsion. The two stars were obtained in 'sandwich' emulsions exposed on the Jungfraujoch (3,500 m.).

Fig. 1 is a photomicrograph of a large 'double star' in which at least eighteen charged particles are emitted. The heavy track A, 195 μ long, tapers towards the end of its range due to a gradual loss of charge as the nucleus picks up electrons. The 'thin-down length' is about 65 μ, indicating[5] a charge of $11 \pm 1\ e$. The energy of the particle producing this track is estimated as 325 ± 50 MeV., and its momentum as $3{,}500 \pm 400$ MeV./c.

A second heavy particle emitted in this event either splits up spontaneously, or disintegrates a nucleus, after traversing 6 μ of emulsion. Assuming the former, its charge is at least 6 e, as two protons and two α-particles are emitted in this secondary event. Since, in addition, eight protons and five α-particles leave the parent nucleus, the charge of the latter must have been at least $35 \pm 3\ e$. It seems likely, therefore, that this event represents the complete disintegration of a bromine nucleus.

The background grain-density is very high in this plate, so the fainter proton tracks have been retouched in the photograph to make them easily visible. The emulsion contains 5 μ layers of pure gelatine, causing discontinuities in the tracks where the charged particles pass through these sandwich layers.

The second disintegration (see Fig. 2) was observed in an emulsion containing thin layers of lead phosphate, and coated on a 250-μ acetate base. This film was one of a pile, and the heavy particle from the star penetrates the last three films of the stack. Its equivalent range in emulsion is at least 2,000 μ. A comparison of its δ-ray frequency with that along the track of a fast α-particle of known energy indicates that it is of charge $5 \pm 1\ e$ and hence energy 350 ± 100 MeV. and momentum $2{,}500 \pm 600$ MeV./c.

If we assume that the energy of the emitted neutrons is about equal to that of the protons, then the excitation energy required to produce these stars is estimated as at least 700 MeV. in the first case and 500 MeV. in the second. The apparent resultant momentum in each star is approximately 3,000 MeV./c, and is directed downwards, assuming the distribution of the neutrons to be roughly isotropic.

The primary particles responsible for these two stars leave no apparent tracks in the emulsion, and so must have charge less than three, since the smallest

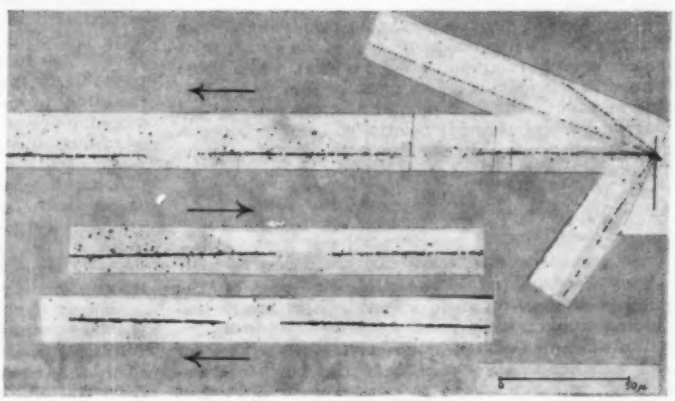


Fig. 2. Nuclear disintegration in which a heavy particle penetrating three films is emitted. The separate mosaics are sections of the tracks in three successive films. Observer: D. H. Perkins

ionization observable in Ilford *C*.2 plates is approximately six times minimum. In order to carry this momentum with a moderate mass, they must be moving with relativistic velocities. Hence the energy transfer, of the same order as the momentum transfer, is very large compared with the estimated excitation energy. The remaining energy can be accounted for either by assuming the isotropic emission of several very energetic neutrons, or perhaps by multiple meson production.

Note added in proof. Since communicating this letter, Dr. G. P. S. Occhialini has sent us details of a taper track similar to the one shown in Fig. 1. See Bonetti, A., and Dilworth, C., Bulletin de l'Université Libre de Bruxelles Note No. 7, January 1949.

P. E. Hodgson
Imperial College of Science D. H. Perkins
and Technology, S.W.7. Jan. 31.

[1] Harding, Lattimore and Perkins, *Proc. Roy. Soc.* (in the press).
[2] Heitler, Powell and Fertel, *Nature*, **144**, 283 (1939).
[3] Lovera, G., *Ric. Sci. Ricostruz.*, **17**, 2045 (1947).
[4] Schopper, E., *Naturwiss.*, **34**, 118 (1947).
[5] Freier, Lofgren, Ney and Oppenheimer, *Phys. Rev.*, **74**, 1818 (1948).

Cross-Section for Nuclear Disintegration Produced by Cosmic Rays

It has been suggested[1] that the cross-section for star production is proportional to the geometrical cross-section of the nucleus. In order to establish this by direct experiment, we have exposed some 'gelatin sandwich' plates for fifty days at a height of 3,650 m. These plates consist of four layers of Ilford *C*.2 Nuclear Research emulsion, 30 μ thick, separated by three thin layers of plain gelatin. This sandwich emulsion, coated on an acetate base, was supercoated with a 5 μ gelatin layer. A second batch of plates with emulsion layers of 25 μ was exposed for forty days. In order to determine the thickness of the gelatin layers (excluding the supercoat) relative to the normal emulsion, we have measured the ratio of the projections in the plane of the emulsion of track length to gap length for those tracks which pass right through the sandwich emulsion. The gaps in the tracks occur when the ionizing particles pass through the gelatin layers. From these measurements on 300 tracks of length greater than 200 μ we conclude that in the plates so far examined the mean gelatin thickness : mean emulsion thickness equals 9·2 per cent.

Stars formed in the emulsion proper can arise through the disintegration of any of its constituent nuclei (silver, bromine and light nuclei), while those formed in the gelatin layers must be due to the disintegration of carbon, oxygen or nitrogen. A charged particle passing through gelatin will not produce a developable track. Hence the latter group of stars are easily recognized as their centres are not visible. From the careful scanning of 94 sq. cm. of these plates we have so far observed

$$\frac{\text{No. of gelatin stars}}{\text{No. of emulsion stars}} = \frac{30}{516} = 5{\cdot}8 \pm 0{\cdot}7 \text{ per cent.}$$

The error quoted is the probable error on the number of stars obtained in the gelatin layers (excluding the supercoat).

We will now assume an effective cross-section for star production proportional to the nuclear cross-section, which we take proportional to $A^{2/3}$. Let ρ_r be the concentration in gm./c.c. of the rth component of atomic weight A_r; suffixes E and G are used to denote emulsion and gelatin respectively. If N is Avogadro's number

$$\frac{\text{Number of gelatin stars}}{\text{Number of emulsion stars}} = \frac{\sum_{rG} \frac{N\rho_{rG}}{A_{rG}} A_{rG}^{2/3}}{\sum_{rE} \frac{N\rho_{rE}}{A_{rE}} A_{rE}^{2/3}}.$$

From the composition of the emulsion and gelatin layers, as quoted by the manufacturers, and from the area of plates scanned, we calculate this ratio to be 4·53 per cent.

Experimental results therefore indicate that the ratio of the cross-sections for star production in light and heavy nuclei is greater than the ratio of their nuclear cross-sections. The results obtained indicate that in normal emulsion 36 $\pm$ 4½ per cent of stars are due to disintegration of light elements instead of 27 per cent as calculated from an $A^{2/3}$ law.

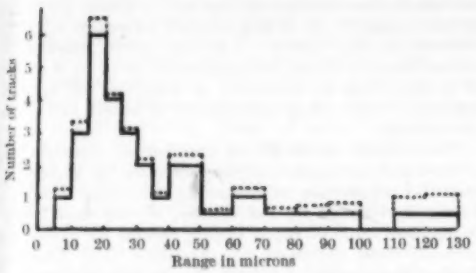
Analysis of gelatin stars. It is clear that large stars cannot be produced in the gelatin, for only light nuclei are present. The largest stars so far obtained in this laboratory have five prongs, one of which corresponds to the complete disintegration of oxygen into three α-particles, two protons and neutrons. The observed numbers of 2-, 3-, 4- and 5-pronged stars are 4, 16, 8 and 2 respectively. In so far as the statistics allow, this size distribution is seen to be similar to the one observed for the small stars (less than six prongs) in normal emulsion[2].

It is extremely difficult to distinguish between the track of an α-particle (less than 50 MeV.) and that formed by a heavier particle such as lithium or beryllium. In the gelatin stars we have observed a total of fifty-five singly charged particles and forty-three having at least two charges. Assigning a charge of exactly $2e$ to each of this latter group, we find the average charge permitted per star is $4{\cdot}7\,e$, which is about $2e$ less than the average nuclear charge. This 'loss' of charge might be accounted for in three ways : (1) by the ejection of very fast singly charged particles which do not leave visible tracks in the emulsion ; (2) by the ejection of a group of charged particles of short range, the majority of which remain in the gelatin layer ; (3) by assigning more than two charges to a number of the heavily ionizing particles.

At present we cannot estimate the effect of process (1) ; but experiments with electron-sensitive emulsions should enable us to obtain the number of very high energy particles ejected per star.

Regarding the second process, it may be noted that in normal emulsion only one third of the small stars have tracks of less than 10 μ (average range, 5 μ)[3]. If all these come from light nuclei, which seems improbable, a maximum of about one track of short range is produced per light disintegration. The stopping power of gelatin is about half that of normal emulsion, and so such tracks should have a mean range of 10 μ in gelatin. The probability of a track of length l remaining in a layer of thickness d is $d/2l$. Hence with d, the thickness of the gelatin layer, equal to 3·6 μ, the probability of a track of 10 μ remaining in the gelatin is about one-fifth. Thus four-fifths of such tracks should pass into the emulsion, and we might reasonably expect to see half of these. As yet we have not observed any. It therefore seems that the estimate of one short track per star is far too high (possibly by a factor of 3). We think it is unlikely that even an average charge of $\frac{1}{2}e$ could escape detection, due to the thickness of the gelatin layer.

It therefore seems probable that about half the heavily ionized tracks are formed by particles having a charge in excess of that carried by an α-particle.



The range distribution of the complete heavily ionized tracks is shown in the accompanying histogram, which has been corrected for loss of tracks due to (*a*) those remaining in the gelatin layers, (*b*) those which pass out of the emulsion. The corrected distribution is shown by the dotted curve.

This work is being continued, and will be reported more fully upon completion.

J. B. Harding

Imperial College of Science and Technology,
London, S.W.7. Jan. 25.

[1] George, E. P., *Nature*, **162**, 333 (1948).
[2] Thomson, G. P., Bakerian Lecture Roy. Soc., 1948.
[3] Harding, J. B., *Phil. Mag.* (in the press).

Structure of Molecular Films of Stearic Acid on Copper

Electron diffraction patterns obtained during an investigation of the effect of temperature on mono- and multi-molecular layers of stearic acid on copper have produced evidence for the existence of crystallites of a metal soap on the copper surface.

The layers of acid were deposited by the Langmuir–Blodgett method[1] on a metal surface which had been finely polished with rouge on 'Selvyt', degreased electrolytically and rinsed in distilled water. Three or more layers give diffraction patterns at 20° C. consisting of strong grease bands (Fig. 1), corresponding to the different orders of the 2·54 A. alternate carbon-to-carbon spacing in the hydrocarbon chain. On raising the temperature of the metal support, the bands gradually fade. At 80–85° C., while the band pattern is still visible, continuous rings corresponding to spacings of 3·76, 4·17 and 4·38 A. appear (Fig. 2). These rings increase in intensity with temperature, and at approximately 100° C. begin to arc. Further faint rings appear, until, at 115° C., there is a strong cross-grating pattern (Fig. 3). The pattern persists until at a temperature of 127–130° C. it fades suddenly, leaving a diffuse background.

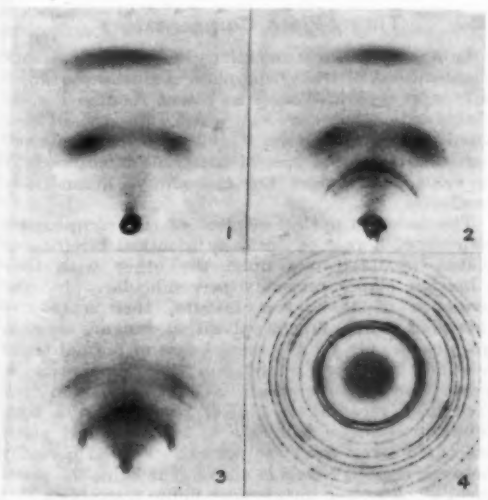


Fig. 1. Reflexion pattern of 7 layers of stearic acid on copper at 20° C.
Fig. 2. Same, after heating to 95° C.
Fig. 3. Same, after heating to 115° C.
Fig. 4. Transmission pattern of copper stearate dissolved from copper surface

The obvious conclusion, that the rings are due to the appearance of copper stearate, was confirmed by comparison of the planar spacings with those obtained from transmission patterns of a copper stearate powder prepared in the laboratory. When a specimen giving the pattern shown in Fig. 3 is boiled for several minutes in pure benzene, the subsequent solution after evaporation on a collodion support gives a strong transmission pattern (Fig. 4). The strongest two rings correspond to spacings of 3·76 and 4·17 A.

From these observations it would appear that at some temperature below 80° C. the stearic acid begins to melt (if one can speak of melting in such layers), reacts with the copper and forms copper stearate. (The bulk melting point of stearic acid is 69° C.; copper stearate softens at approximately 125° C. The effect of the metal surface on the melting point of molecular layers of such compounds is being investigated.) The stearate gradually collects into discrete crystallites, projecting from the metal surface and showing some preferred orientation. The pattern indicates that the crystals are oriented with their (001) plane parallel to the metal surface. At 130° C. the crystals melt.

Further experiments, however, indicate that, if the multi-layers on copper are allowed to age for some days, similar crystallites are obtained at temperatures well below the melting point of stearic acid. Melting of the acid apparently merely accelerates the reaction and subsequent crystallization.

Reaction between molecular layers of polar compounds with the underlying metal or metal oxide surface has been proposed by previous workers[2–4]; but no definite electron diffraction evidence of the existence of the products of such reactions has previously been reported. The conception of the crystallization of multilayers of long-chain compounds is not a new one. Coumoulos and Rideal[5] reported in 1941 that molecular layers of long-chain esters on nitrocellulose supports crystallized on ageing.

Further work on other metals is in progress.

My thanks are due to Dr. A. L. G. Rees for permission to use the electron diffraction camera of the Chemical Physics Section, Division of Industrial Chemistry, and for his constant advice and criticism. The work forms part of the general programme of research of the Tribophysics Division of the Council for Scientific and Industrial Research.

J. A. Spink

Tribophysics Division,
Council for Scientific and Industrial Research,
University of Melbourne.

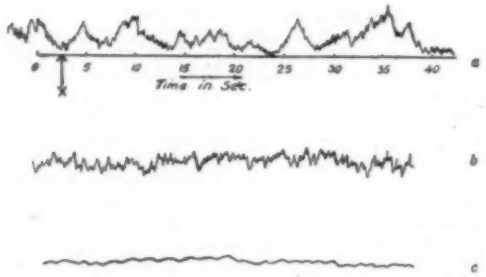
[1] Blodgett, K. B., *J. Amer. Chem. Soc.*, **57**, 1007 (1935).
[2] Bowden, F. P., Gregory, J. N., and Tabor, D., *Nature*, **156**, 97 (1945).
[3] Tanaka, K., *Mem. Coll. Sci. Kyoto Imp. Univ.*, A, **22**, 377 (1939).
[4] Brummage, K. G., *Proc. Roy. Soc.*, A, **191**, 243 (1947).
[5] Coumoulos, G. D., and Rideal, E. K., *Proc. Roy. Soc.*, A, **178**, 421 (1941).

A Peculiar Type of Rapid Fading in Radio Reception

WHILE studying the field-strength variations at Waltair of transmissions from certain broadcasting stations of the All-India Radio, a peculiar type of rapid fading, which does not appear to have been reported so far, was observed during the summer months on the 41- and 60-metre bands. The phenomenon may briefly be described as the apparent existence on the carrier, at the receiving end, of a permanent modulation of 2–3 cycles per second. When the programme is on, there is superposed on it a variation in intensity at frequencies ranging between 2 to 3 cycles per second. This gives the impression of a quivering or fluttering of the transmission. This phenomenon is therefore referred to here as the 'flutter phenomenon'. The effect produced in the loud-speaker by the 'flutter' is somewhat similar to the beating of two notes of nearly the same frequency. When the quasi-frequency of the 'flutter' becomes large, it produces a most annoying effect, and listening to a programme becomes almost impossible. The effect is further accentuated by occasional large amplitude of the 'flutter'.

A study of the phenomenon with respect to the evening and night transmissions of All-India Radio (Madras) showed the following features: (1) It occurs only during the summer months. In 1948 it started about the second week of February and continued to the end of June almost every day. (2) The 'flutter' appears at about the period of sunset. The quasi-flutter frequency is low (about 20–30 c./min.) before sunset, but increases (to 120–140 c./min.) up to a point in the night and thereafter remains practically constant.

Although this effect was observed on the Madras transmissions, it was noticed on the 41-, 49- and 60-metre bands transmissions from other stations of All-India Radio as well, and occasionally on the 19-metre band. It is completely absent on the medium wave-band.



A trace of galvanometer records incorporated in a field-strength measuring equipment is given in the accompanying diagram: curve (*a*) refers to All-India Radio (Madras) on 41 metres; curve (*b*) to the Colombo transmissions on 61 metres; and curve (*c*) refers to the transmission of All-India Radio (Trichinopoly) on 396 metres. The curves were taken at 2000 and 2045 hr. I.S.T., on June 16, 1948.

It is seen from the curves that there is a slow fading with periods ranging from 3 to 4 sec. giving rise to what clearly appears as the usual slow type of fading, the signal strength fluctuating between 2,000 μV./m. to 200 μV./m. Superposed on this are the small, fine discontinuities which make the trace appear rugged. It is this rugged structure which is noticed as the 'flutter'. At the point marked *X*, the number of these discontinuities is 12 in a period of 5 sec., that is, it occurs at intervals of approximately 0·5 sec. or at a frequency of about 140 cycles per minute.

The rugged structure of the curves reminds one of the irregular scatter groups obtained by Eckersley[1] and the occurrence of flickering reflexions from the *F*-region reported by Beckmann, Menzel and Vibig[2]. A peculiar type of rapid fading (about 37 cycles per minute) was observed by Appleton and Beynon[3] during the period of sunset due to the reception of the Pedersen ray. The phenomenon described here is different from the above in that the rapid fading noticed by the above authors was only during a period of 14 min. passing through sunset; but the one described here commences about the period of sunset and persists over long periods. Therefore the ionosphere must in some way be responsible for the 'flutter' phenomenon, although the exact method of production of this effect is not known. If the rapid movement of the ionic clouds across the *F*-layer is a regular process as observed by Wells, Watts and George[4], the effect reported above may be produced by these clouds. The speed and the number of clouds that pass a given point in space may to a large extent determine the frequency of the rapid fading produced.

N. S. SUBBA RAO
Y. V. SOMAYAJULU

Physics Department,
Andhra University,
Waltair, India.
Sept. 5.

[1] Eckersley, T. L., *Nature*, **143**, 33 (1939).
[2] Menzel, Beckmann and Vibig, *T.F.T.*, **28**, 130 (1939).
[3] Appleton and Beynon, *Proc. Phys. Soc.*, **59**, 72 (1947).
[4] Wells, Watts and George, *Phys. Rev.*, **69**, 540 (1946).

Tilting-Plate Compensators

THE various communications describing ingenious modifications of the tilting-plate compensator which have appeared in *Nature* in recent months suggest that a rather different form, which I improvised from a pair of selenite plates, might be of some interest, particularly as the special materials mentioned by previous contributors are not always immediately available.

The essential optical element of this compensator consists of a pair of optically identical birefringent plates, mounted one upon the other with their vibration planes mutually perpendicular. In consequence of the latter feature, their respective retarding powers are in opposition, but are equal in magnitude only for the special case of normal transmission, the total retardation then amounting to zero. For all other directions of transmission their respective retardations differ, resulting in a total retardation which increases as the combined plates are tilted away from the normal. Viewed normally between crossed Nicols in convergent light, the plates yield a conoscopic interference figure resembling that of a single plate of uniaxial material cut perpendicular to the optic axis. It is thus possible to construct a tilting optical element giving a zero retardation for normal transmission.

The advantage of this form of compensator is that the plates can be made from almost any birefringent material whatsoever, since the orientation of the optic axis or axes does not affect the mutual neutralization for normal transmission. The present optical element consists of two plates of selenite of 2·5 mm. thickness, giving a compensating range of about four wave-lengths; but mica would probably be preferable because it would permit of thinner plates. In the case of the most common form of mica, the normal bisects the acute angle of the optic axes, so that a pair of opposed mica plates have to be tilted through only a comparatively small angle to bring an optic axis of one of them into coincidence with the direction of transmission. When one of the mica plates is in this particular position, its retarding effect is zero, while that of the other will be rather greater than for normal transmission. Consequently, if each mica plate is of such thickness as to introduce a retardation of, say, four wave-lengths, a total retardation exceeding this value will be obtained when the plates are combined in opposition and tilted into the above position.

The calibration may be computed along the lines mentioned by F. Record[1], with the difference that there are two plates to be computed separately, each pair of values corresponding to a given angle of inclination being afterwards added to provide the calibration curve.

Mounting the two plates separately in such a manner that they can be tilted independently of one another suggests further possibilities which might be worth investigating.

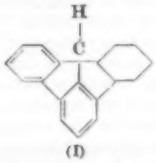
F. Hughes Smith

30 West Park Avenue,
Newby, Nr. Scarborough.
Sept. 24.

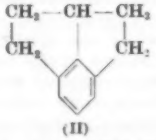
[1] *Nature*, **162**, 454 (1948).

1 : 9-*cyclo*Hexylenefluorene

Hurd and Mold[1] have recently described the dehydration of 2-fluorenyl*cyclo*hexanol to a saturated hydrocarbon to which they attribute the structure (I) of 1 : 9-*cyclo*hexylenefluorene. If this structure were correct, the result would be of considerable importance, for it would represent the first successful attempt to prepare a compound having the highly strained ring-system (II) which von Braun had completely failed to obtain[2].



(I)



(II)

It is very unlikely, however, that the hydrocarbon of Hurd and Mold has the structure (I). The dehydration of their carbinol is probably analogous to that of 2-benzyl*cyclo*hexanol, which gives a bridged ring hydrocarbon[3]. Experiments to test this hypothesis are being initiated.

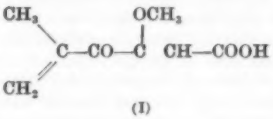
J. W. Cook

University of Glasgow.
Sept. 18.

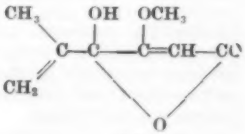
[1] Hurd, C. D., and Mold, J. D., *J. Org. Chem.*, **13**, 339 (1948).
[2] See Johnson, W. S., "Organic Reactions", **2**, 124.
[3] Cook, J. W., and Hewett, C. L., *J. Chem. Soc.*, 62 (1936).

Tautomerism of Penicillic Acid

The existence of tautomeric forms of penicillic acid was first postulated by Birkinshaw, Oxford and Raistrick[1]. Recent workers have tended to the view that the hypothesis of tautomerism was not needed to explain the chemical properties of penicillic acid[2].



(I)

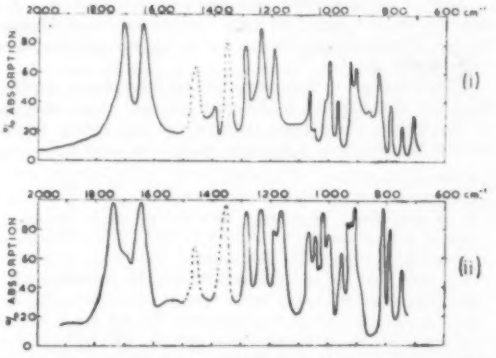


(II)

However, the infra-red spectra of penicillic acid furnish conclusive evidence for the existence, in the solid phase at least, of two tautomeric forms. The infra-red spectra of the two forms are shown in Figs. (i) and (ii). Spectrum (i), with carbonyl absorption band at 1,714 cm.$^{-1}$, is that of the keto acid (I); and spectrum (ii), with carbonyl absorption band at 1,738 cm.$^{-1}$, is that of the lactone form (II). Key bands for each form are:

Keto acid	1,714	1,393	967	831			cm.$^{-1}$
Lactone	1,738	1,165	1,032w	956	935	808	cm.$^{-1}$

The infra-red spectrum of the sodium salt of penicillic acid has been obtained. This contained no lactone carbonyl absorption band, but a powerful new band at 1,550 cm.$^{-1}$ was observed, indicating the formation of a carboxyl ion. It was concluded that the sodium salt was the salt of the keto acid and not an enolic salt.



The two forms of penicillic acid can be readily interconverted. The lactone form was produced by melting the keto acid and allowing it to crystallize. It was also formed by prolonged grinding of the keto acid in 'Nujol'. When the lactone form was dissolved in ether and recrystallized, the keto acid was again produced. By suitable physical treatment, all types of mixture from 100 per cent form I to 100 per cent form II can be obtained.

A number of analogues of penicillic acid have been examined; but no further examples of tautomerism have been observed.

In view of the widespread use of the method of grinding in 'Nujol' for analytical work in the infra-red region, attention may be directed to the fact that in the case of materials existing in tautomeric forms with small energy differences, radical changes in the infra-red absorption spectrum can be produced by grinding. Prolonged grinding has been recommended[2] as a means of securing random orientation of the crystals in the absorption cells; but the possibility of changes occurring due to tautomeric interconversion should always be borne in mind.

A full account of this work will be published elsewhere. Thanks are due to Dr. R. A. Raphael for his kindness in supplying specimens of synthetic[4] and natural penicillic acid and their analogues, to Mr. L. Beecher for assistance with the experimental work, which was carried out for the Chemical Inspectorate, Ministry of Supply, at the Royal Arsenal, Woolwich, and to the Chief Scientist, Ministry of Supply, for permission to publish.

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Oxidation of α-Diketones and α-Keto-Acids by Hydrogen Peroxide

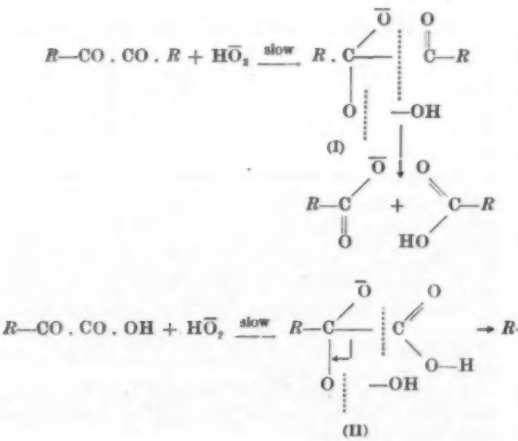
THE oxidation of α-diketones and α-keto-carboxylic acids by hydrogen peroxide involves the breaking of the carbon–carbon bond between the carbonyl carbon and the carbonyl or carboxyl groups[1].

$$R\text{—CO . CO . } R + H_2O_2 \rightarrow 2R\text{—CO . OH};$$

$$R\text{—CO . CO . OH} + H_2O_2 \rightarrow R\text{ . CO . OH} + H_2O + CO_2.$$

This note discusses the mechanism of these reactions in the light of new experimental evidence, and in terms of suggestions I and my co-workers have previously made[2].

The kinetics of these oxidations have been studied in aqueous solutions, and a very marked base catalysis is observed. Such base catalysis is frequently found in the reactions of hydrogen peroxide, and it is considered to indicate a rate-determining attack by the hydroperoxide ion, formed by the ionization of the hydrogen peroxide. The reaction mechanism suggested for the reactions now considered involves the addition of this nucleophilic ion to the carbonyl carbon atom. The conclusion that the addition is rate-determining is in accord with what is known concerning additions of other nucleophilic anions, for example, the cyanide ion, to carbonyl groups.



The kinetics give little information as to the life of the intermediates, I and II, which probably have at most a transient existence.

The base catalysis is observed in the oxidation by hydrogen peroxide of diacetyl and sodium pyruvate, and also of benzil and sodium benzoylformate. Neither of these latter compounds can undergo enolization, and therefore this base catalysis cannot be explained by any mechanism which involves the enolization of the compound.

Mechanisms involving free radicals derived from hydrogen peroxide are also excluded under our experimental conditions. It is found that hydrogen peroxide in the presence of slightly acid ferrous or ferric salts, a recognized source of free hydroxyl radicals[3], does not readily decarboxylate benzoylformic acid. Furthermore, pyruvic acid can actually be prepared by the oxidation of lactic acid with ferrous sulphate and hydrogen peroxide[4].

A detailed account of this work will be published later.

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Demethylation of N : N-Dimethyl-p-Aminoazobenzene (Butter Yellow) with Hydrogen Peroxide

THE reaction which butter yellow undergoes with the Milas reagents[1] (hydrogen peroxide in *tert.* butyl alcohol with osmium tetroxide as catalyst) is being studied in detail to determine the extent to which it parallels the reaction occurring with this substance *in vivo*, since the *in vitro* reaction is accompanied by a chemiluminescence[2]. Miller and Miller[3,4] have recently given evidence that hydroxylation of butter yellow or its demethylated derivatives occurs to some extent in the rat, and, as it was expected that the Milas reagents would effect hydroxylation of the substance, they seemed suitable for the comparison. Separation of the reaction products, however, also showed that much of the action had taken place at the tertiary nitrogen atom. The following results have been obtained so far.

0·75 gm. of butter yellow, which had been previously freed from traces of the monomethyl compound and the free base by chromatography using an alumina column and petroleum ether (60–80° C.) as solvent and eluent, was dissolved in 270

ml. of an 8·1 per cent solution of hydrogen peroxide in *tert.* butyl alcohol, and 7 ml. of a 0·5 per cent solution of osmium tetroxide in *tert.* butyl alcohol was added to this. The mixture was maintained at 37° C. for 12 hours, since this was the temperature at which the chemiluminescence observations had been made. The alcohol solution was then diluted to 2 litres with water and extracted with 4 litres of benzene. The benzene extract was concentrated and passed on to an alumina column. After elution of the different zones and repeated chromatography of these, a large number of different eluates was obtained. The materials producing four of these zones were (*a*) 0·11 gm. unchanged butter yellow, (*b*) 0·13 gm. N-methyl-*p*-aminoazobenzene, (*c*) 0·013 gm. *p*-aminoazobenzene, (*d*) 0·013 gm. *p*-nitroazobenzene. The materials were identified by comparison of solubilities and colours in dilute hydrochloric acid, chromatographic behaviour and finally melting-points, with those of samples of known compounds. For the small fractions of *p*-aminoazobenzene and *p*-nitroazobenzene, absorption spectra provided confirmatory evidence. Another small fraction has been obtained which has acid and basic properties and would therefore seem to be a hydroxyl derivative of butter yellow or its demethylated products.

The remainder of the reaction products are still being investigated; but the reactions which take place at the dimethylamino-group seemed worthy of separate note. The removal of alkyl groups from aromatic tertiary amines is not uncommon in *in vivo* reactions; but little is known of the reaction mechanism and the process is simply referred to as 'dealkylation'. Studies with amine oxidase[5,6] show that a number of amines undergo oxidation at the carbon–nitrogen linkage in the presence of this enzyme, and the experiments of Hess *et al.*[7] on cyclic $>N.CH_3$ compounds containing a ketone or aldehyde grouping (derivatives of pyrrolidine and piperidine) afford examples of intramolecular oxidative demethylation. The reaction described above provides an example of oxidative demethylation of an aromatic tertiary amine, effected by hydrogen peroxide.

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Methylation in the Study of Polynucleotides

ALTHOUGH detailed knowledge of the components of pentose nucleic acids is still incomplete, considerable effort over a long period has been directed towards the problem of the mode of union of the constituent nucleosides. It was early recognized that these units are linked through phosphoric acid residues, and the precise manner in which this takes place has been studied more recently by electrometric titration[1].

As regards the groups in the nucleoside radicals which are concerned in the structure of the polynucleotide, direct evidence that carbohydrate hydroxyl groups are involved is scanty. It is now known that all four nucleotides, isolated after mild alkaline hydrolysis of the pentose polynucleotide of yeast, possess phosphoric ester groupings at position 3 of the sugar residue, and the question has been discussed whether di-ester linkages exist between positions 2 and 3 or 3 and 5 of the different nucleosides making up the polynucleotide[2]. Since, however, yields of the nucleotides are always far below expectation, it cannot be assumed that all the nucleosides are esterified in this way, and an open mind must be kept regarding the precise parts played by the carbohydrate radicals and the phosphoric acid residues in the internucleosidic linkages.

It is clear, therefore, that a technique is required whereby uncombined carbohydrate radicals may be counted and identified, in order that a complete picture of the mode of linkage of the carbohydrate radicals may be obtained. Methylation of yeast nucleic acid has been investigated with this end in view, as mentioned by the late Prof. J. Masson Gulland[3]. Since his death, this work has been carried forward and is now briefly reported. Levene records that the use of Purdie's reagent[4] brought about decomposition of nucleotides and nucleosides at a greater rate than methylation. In the absence of experimental details concerning this breakdown, it was decided to attempt again to make use of this reagent for the methylation of the pentose polynucleotide of yeast.

Repeated treatment of a suspension in methanol of yeast nucleic acid purified by the method of Sevag, Lackman and Smolens[5] with methyl iodide and silver oxide resulted in the formation of approximately eight, and no more, methoxyl groups per statistical tetranucleotide, four of which were assumed to be located on the phosphoric acid residues, since they could be hydrolysed readily by boiling aqueous sodium hydroxide. It was found that if methylation was carried out at the boiling point, the product was pale brown in colour, was deficient in nitrogen and contained no methylamino groups. If, however, experiments were conducted with vigorous shaking at 25° C., methylation proceeded satisfactorily, giving a pale straw-coloured hygroscopic powder, soluble in water and methanol, but insoluble in methyl iodide, acetone and ether, and possessing eight methoxyl groups as before and also approximately six methylamino groups per statistical tetranucleotide.

The degree of success attained in these experiments must be judged, for the present purpose, according to the extent to which the state of combination of carbohydrate hydroxyl groups involved in the internucleosidic links has been altered during methylation. If the assumption, for which there is no real justification at present, be made that carbohydrate radicals are involved in all the internucleosidic linkages, the molecular weight of the methylated product is probably the most reliable criterion. Accordingly, molecular weights were determined by the method of Fletcher, Gulland and Jordan[6] before and after methylation, and it was found that the nucleic acid had suffered no appreciable degradation. The values of the molecular weights, estimated from measurements of the diffusion coefficients by making the same assumptions as those made by Fletcher, Gulland and Jordan[6], range from 10,000 to 12,000 for the nucleic acid before methylation, and from 13,000 to 15,000 after treatment. It is considered, therefore, that this method of investigation promises well to

attain in some measure the object in view. Before it is possible to state exactly the nature of nucleic acid methylated in this way and to isolate and identify fragments of the molecule, a study must be made of the effects of the above reagents on simple constituents of the polynucleotide molecule. Work is in progress to this end and will be reported elsewhere.

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Resonance and Molecular Structure

There is now sufficient evidence available from accurate measurements of molecular dimensions to state with a fair degree of certainty that the ideal hybrid bonds of quantum mechanics are only found where the symmetry of the bonded system is identical with that of the hybridized atomic orbitals. It would seem that the presence of any asymmetry caused the angles between the bonds to deviate from the ideal values characteristic of the symmetrical system. Since the deviations are generally quite small (though now well outside the possible limits of experimental error in favourable cases) it seems probable that these asymmetric systems are resonance hybrids, in which there are small contributions from structures usually ignored. Thus, it is possible to account for the observed facts in the methyl halides as follows.

We assume that the ψ-function of the molecule CH_3X can be written as a linear combination of three functions characteristic of the structures I to III below:

$$\underset{\text{(I)}}{CH_3{-}X} \qquad \underset{\text{(II)}}{\overset{+}{C}H_3\ \overset{-}{X}} \qquad \underset{\text{(III)}}{\overset{-}{H}\ CH_2{=}\overset{+}{X}}$$

there being three equivalent structures III. In symbols,

$$\psi = a_1\psi_{\text{I}} + a_2\psi_{\text{II}} + a_3\psi_{\text{III}}, \qquad (1)$$

where $a_1^2 + a_2^2 + a_3^2 = 1$.

The required data are summarized below

X =	F	Cl	Br	I	
[1] $\theta_{\angle HCH}$	111° 48′	111° 52′	112° 0′	112° 12′	
[2] k_{CH}	4·71	4·90	4·95	5·00	$\times 10^5$ dynes/cm.

The small variations are thought to be real. The decrease in the C—H stretching constant k_{CH} encountered in passing from iodide to fluoride suggests an increase in a_2 in (1) in the same direction; this would be expected from what is known of the relative powers of conjugation of the halogen atoms. Now if we assume that in the structure (1), in which $a_2 = 0$, the two single bonds from III are effectively distributed over a cone with vertical angle 120°, cylindrically symmetrical about the axis C_3, then the angle HCH in the hybrid will be less than the normal tetrahedral value, the increment increasing with a_3. If, in addition, we assume that the positive methyl ion in II is itself a resonance hybrid, with a small contribution from the trigonal sp_2 structure (which seems reasonable, since here there are only three bonds actively employed), then the angle HCH in II will be greater than normal. Clearly, the structure (I) in which $a_3 = 0$ will then also have HCH angles greater than normal. If now both a_2 and a_3 are non-zero, and a_3 increases with respect to a_2 in passing from iodide to fluoride, then all the facts can be explained.

As a second example, consider the anomalous fluorinated ethylenes. In both vinylidene fluoride and tetrafluoroethylene, the C=C stretching frequency is abnormally high[3]. Resonance with structures of the type $\overset{-}{C}H_2{-}CF{=}\overset{+}{F}$ will account for increased C—F stretching frequencies, but would lead simultaneously to a decrease in $\nu_{C=C}$. It has been found that the non-planar $=CH_2$ bending frequency can be used as a measure of the extent to which the above resonance occurs in substituted ethylenes[4]; the large effect observed in vinyl and vinylidene fluorides[3,4], if all attributable to this resonance, would certainly be associated with a decrease in $\nu_{C=C}$. The observed increase can only come from resonance with structures such as $\overset{+}{H}\ CH{\equiv}CF\ \overset{-}{F}$, which become of importance with the fluorides because of the high electro-negativity of fluorine. It is possible that the large negative increments in δ_{CH_2} are also partly due to structures of the above type, since it is known that δ_{CH} is smaller for C—H bonds adjacent to triple bonds. Further, such structures would diminish the angle FCF; there is some evidence[3] that in $CH_2{=}CF_2$ this angle is as small as 112°.

There are other cases where the same principle may be applied. Thus, in formaldehyde[1], resonance with the single-bond structure $\overset{-}{O}{-}\overset{+}{C}H_2$ accounts for the increase (of 3° 26′) in the angle HCH over the normal trigonal value of 120°, the argument being analogous to that used to explain the assumed decrease of the tetrahedral HCH angle in the resonance hybrid $\{CH_2{-}X,\ \overset{-}{H}\ CH_2{=}\overset{+}{X}\}$. In phosgene, the chlorine atoms favour resonance of the type $\{O{=}CCl_2,\ \overset{-}{O}{-}C\overset{+}{Cl}{=}Cl\}$, which would leave the trigonal angle unaffected; actually a decrease is observed, ($\theta_{\angle ClCCl}$ = 117°)[5], which may be attributed to the presence of small contributions from structures $O{=}C{=}\overset{+}{Cl}\ \overset{-}{Cl}$.

In conclusion, it may be mentioned that there is some evidence to show that the directions of bonds may be inclined at an angle to the line joining the nuclei of the bonded atoms. This idea was developed in connexion with highly strained cyclic systems[6]; but it is possible that it is applicable to the cases discussed in this note.

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Radioactive Emanating Power and Ultrasonic Treatment

It seems in certain cases reasonable to suggest an influence of ultrasonic treatment on radioactive emanating power[1]. Ultrasound may bring about changes in a solid substance which involve changes of the emanating power, either by affecting the specific surface or the diffusion coefficient of the emanation in the solid phase. A change of the former property should be permanent or show remanence, whereas a change of the latter should be restored after ceasing ultrasonic treatment. It should thus be possible to conclude which of the two changes has occurred.

We have started a study of the effect of ultrasound on the emanating power of gels of metal oxide hydrates. A dilute solution of aluminium chloride was precipitated in the cold with ammonia in the presence of radium–thorium. The carefully washed precipitate was centrifuged, and dried for seven days above concentrated sulphuric acid. It was then placed in the open air.

Measurements were made by the streaming method for radium–thorium often described[2], which affords an almost instant reading of the relative changes in the emanating power. In order to measure the activity of the emanation, we used a modification of the ionization electrometer according to Zimens[3]. A Crystalab ultrasonorator, model SL 520, Fisher Scientific Co., with a maximum effect of 500 watts was used as ultrasonic source. The frequency was 1,500 kc. The sample was exposed to the ultrasonic waves through the thin wall of a glass tube, which was placed in the oil fountain.

The experiments so far made have shown an immediate increase in emanating power caused by the ultrasonic waves. Thus in a typical experiment we got an increase amounting to 26 per cent. The high value remained constant for an hour, after which a slow decrease might perhaps be observed. The increase depends on the sound effect. In another experiment we got an increase of 24 per cent, at a generator output of 100 watts, and this value increased gradually to 33 per cent, as the generator output was increased to 500 watts. It must be remembered that the efficiency in this simple but typical experimental arrangement can scarcely be ascertained. It is, however, quite low.

These preliminary experiments seem to indicate that treatment with ultrasound brings about a disintegration of the agglomerates of the aluminium oxide hydrogel. From experiments of an entirely different character, Sata and Naruse have come to a similar conclusion[4]. In our case, however, another interpretation is possible, namely, that the ultrasound may have an influence on the amount of water absorbed by the gel, thus causing a change in the emanating power[5].

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Some Pharmacological Properties of Sodium Ethyl, 3 : 3 Dimethylallylbarbiturate

PRELIMINARY observations have shown that when sodium ethyl, 3 : 3 dimethylallylbarbiturate was administered to dogs and cats, it produced a marked stimulation of gastric and salivary secretion. The stimulation appeared to be of central rather than peripheral origin[1–3].

Further studies with this compound, No. 16-*A* (Eli Lilly and Co.), have disclosed that it possesses other powerful pharmacological properties not usually ascribed to barbituric acid derivatives. It appears that the actions of this substance are the exact opposite of the ordinary hypnotic barbiturates. The effects studied so far show that it causes a distinct rise in blood pressure even when given intravenously; it causes an immediate marked stimulation of depth and frequency of respiration, and the body temperature is sharply raised. In unanæsthetized animals, overdosage is associated with restlessness, muscular contractions and violent convulsions. The animal's temperament appears to change, so that it appears frightened and becomes bold and vicious. Sympathetic over-activity may be noted. Death occurs following convulsive episodes and may be due to spasm of respiratory muscles, since anæsthetic doses of ordinary barbiturates may increase the tolerance to five to six times the M.L.D. for unanæsthetized animals.

The M.L.D. for cats and rabbits is approximately six to seven mgm./kgm. when administered intraperitoneally or intravenously. Symptoms occur when doses of 3–4 mgm./kgm. are reached. Cats anæsthetized with pentobarbital will tolerate total doses of 50 mgm./kgm. given over four hours. An intravenous dose of 5 mgm./kgm. in such a preparation caused a rise of 36 mm. mercury in blood pressure, which rapidly returned to normal.

In unanæsthetized animals, respiration is markedly stimulated, and vigorous panting occurs for approximately three hours; the rate may reach 180 per min. The rectal temperature rises to 105–107° F. and may reach 112° F. at death.

The isolated gut suspended in Ringer's solution is first stimulated and then narcotized when total concentrations of 0·01 per cent of 16-*A* are reached. During the latter stage, the gut fails to respond to added acetylcholine or histamine, but the response rapidly returns after washing out the barbiturate solution.

The antagonistic action of this compound to ordinary barbiturates suggests that it may be used to overcome some of their undesirable effects, such as depression of respiration and blood pressure, and might be of value as an antidote to barbiturate poisoning. Preliminary experiments indicate that an anæsthetic mixture of 16-*A* and pentobarbital may be rapidly given intravenously to rabbits without causing respiratory paralysis.

This work was supported by a grant from the National Research Council, Ottawa.

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Colour Vision

HAVING read the article on colour vision in *Nature* of October 23, 1948, and having heard the spontaneous comments of a number of people who have read that article, I am under the impression that readers who were not present at the Brighton meeting have got a somewhat incorrect impression as to the true state of affairs so far as the rival theories are concerned.

In the first place, there appears to have been a misunderstanding as to the interpretation which should be placed on papers recently published by Prof. R. Granit in the *Journal of Neurophysiology*. It is clear that some readers of his paper have gained the impression that Prof. Granit has abandoned the polychromatic theory on the grounds that many, if not all, types of modulator, which he has found in the eyes of animals, might be built up from receptors of three types only: red, green and blue. Let us accept this suggestion in order to examine its implications more closely. By some physiological process of summation or inhibition, the details of which are at present unknown, a trichromatic arrangement of receptors co-operates to produce a number of different functional units, which are distributed fairly uniformly throughout the spectrum, and have somewhat narrower response curves than the receptors from which they are produced. Now the important point, so far as colour vision is concerned, is that such functional units exist, because it is with these that the polychromatic theory is primarily concerned.

With regard to colour-matching data, three incorrect ideas appear to be held by some supporters of the three-colour theory. The first is that a colour match is stable under a wide range of light and colour adaptation. This is contrary to recent experimental findings, because it is now known beyond all possibility of dispute that either a considerable increase of light intensity, or a marked decrease of light intensity, or the adaptation of the eye to a bright light, markedly alters certain colour matches. So also do variations in the size of the test field. There is a further point in this connexion. It used to be supposed years ago not only that one subject with normal colour vision would accept the colour matches made by another, but also that colour-blind persons would do so as well. It is now known, however, that none of these ideas is correct. Not only is it unusual for one subject to accept the colour matches of another, but also it is sometimes found that colour matches made on one day are unacceptable to the same subject on the following day. Moreover, it is true that certain colour-blind persons will accept the matches made by normal-sighted subjects; but this is not true of all types of colour blindness. The protonomalous trichromatic observer may be specifically mentioned in this connexion.

The fact that additive mixtures of red, green and blue radiations produce colours which are too desaturated for an exact match with the spectral colours is claimed to be explicable on the ground that no physical stimulus, particularly no green stimulus, is capable of stimulating only one receptor; that is, that the sensitivity curves are broad ones, overlapping to some considerable extent in the spectrum. Two points should be noted in this connexion: first, that no confirmatory evidence has so far been produced for the statement that the sensitivity curves are broad ones; and secondly, that such an assumption is found to lead to erroneous conclusions so far as certain types of colour blindness are concerned. Thus the failure of additive mixtures to match spectral colours has still to be satisfactorily accounted for on the three-colour theory.

The article in *Nature* of October 23 mentions the point that even if there were a yellow receptor, the sensation of yellowness could not uniquely be associated with its stimulation, on the ground that yellowness can also be produced by a mixture of red and green radiations, and therefore by the combined activity of the red and green receptors. This may indeed be the case; but even if true, it does not throw doubt on the existence of independent yellow receptors. Two interesting points come up for consideration in this connexion. (1) On the basis of the three-colour theory, it would be expected that adapting the eye to yellow rays would produce identical results to those produced by adapting the eye under the same conditions to a red – green mixture which matched the yellow in hue, brightness and saturation; but as previously reported, experiment shows that such is not the case. (2) Certain trichromats with abnormal colour perception describe the yellow parts of the spectrum as 'red – green', that is, there is to them no specific yellow hue which to subjects with normal colour perception is so clearly different either from red or from green. This suggests the possibility that the yellow receptors may have some more specific function to perform than existing evidence indicates. With regard to the evidence for an independent yellow receptor, it is pointed out correctly that this cannot be based on the observation that a yellow pigmented surface is replaced by white when field size is altered. It is based principally on the following evidence: (1) experiments on monochromatic yellow light produced by a monochromator or by a screened sodium electric lamp; (2) the notches which occur in the luminosity curve for foveal photopic vision when light intensity is reduced, or field-size made small; (3) the adaptation experiments referred to above; (4) the disturbance of matches between pure yellow and a red – green mixture.

I would like to terminate these comments by briefly referring to some very recent work performed by Dr. L. C. Thomson. During an examination of the shape of the luminosity curve, when test fields of small size were being investigated, he found instead of a smooth curve, such as is obtained with fields of large size, that one was obtained which showed a series of small humps and depressions, there being a particularly clearly marked hump at a wave-length of 0·42 μ. Now it is especially interesting to note two other facts. First, Granit has recently discovered a modulator which has a crest very close to this wave-length. Secondly, I obtained evidence for a receptor with a crest at, or close to, this wave-length, which possessed a specific fixation point in the fovea, and also a characteristic subjective colour when the foveal centre was explored using the microstimulator apparatus.

The situation so far as the polychromatic theory is concerned may be summarized by saying that evidence is accumulating in its favour, and that the evidence in question is at variance with the three-colour theory. So far as can be judged at present, human foveal vision is approximately trichromatic, but it is also served by additional receptors which disclose their presence under appropriate experimental conditions. To-day it seems less a matter of discussion whether the three- or the poly-chromatic theory is correct, so much as to consider the spectral situation, the spectral distribution, and the retinal

distribution of the additional receptors which are postulated by the polychromatic theory.

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Factors Influencing the Renal Threshold

It appears that threshold substances fall into two groups as regards their mode of tubular resorption. Glucose, xylose, phosphate, sulphate, amino acids and ascorbic acid on one hand have a definite Tm[1,2] value (maximal tubular resorption, mgm./min.) which is a measure of the active tubular cell-mass; the resorption of chloride and bicarbonate ions[3,4], on the other hand, is proportional to the quantity of glomerular filtrate.

The purpose of this note is to discuss the factors on which the threshold values of various substances depend, and to examine whether or not the difference in the resorption mechanism referred to above is reflected in the behaviour of the threshold.

For either group the value of the threshold Tx, mgm. per cent, of a substance x is such that

$$F_0 Tx/100 = Rx_0, \quad (1)$$

where Rx is the amount resorbed in the tubules (mgm./min.), F the rate of glomerular filtration (c.c./min.) and zero subscripts refer to values corresponding to the plasma concentration Tx. Evidently, for substances of the second group, where

$$100.Rx/F = \text{const.}, \quad (2)$$

$$Tx = 100.Rx/F \quad (3)$$

for any pair of values Rx and F[3,5]. This threshold is independent of the concentration of x in the plasma (Px) and of the actual values of Rx and F. It is a characteristic of the tubular function.

For substances of the first group

$$Rx = Tmx = \text{const.}, \quad (4)$$

for $Px \geqslant Tx$, and the formula of Földi *et al.*[6] can be used for the calculation of the threshold:

$$Tx = Px - \frac{P}{U}(Ux), \quad (5)$$

where P/U is the inulin concentration ratio and Ux the concentration of x in urine (mgm. per cent).

From (1), and putting $Rx_0 = Tmx$, we obtain

$$Tx = 100.Tmx/F_0. \quad (6)$$

It will be seen that, in this case, Tx is not a constant, but a function of Tmx and F_0. We have pointed out elsewhere[7] that Földi's formula can only be used if F is constant and independent of Px. It actually is so (as seen, for example, from Shannon and Fisher's data[1] for glucose), so that it is possible to write F instead of F_0 in (6). Thus, for substances having a threshold Tm,

$$Tx = 100.Tmx/F. \quad (7)$$

For every pair of values (Tmx, F), therefore, there is a threshold value $Tx_{(Tmx,\,F)}$.

Földi[8], in a recent communication, has expressed the threshold as

$$Tx = Px.Rx/Fx, \quad (8)$$

where Fx is the rate of glomerular filtration of x mgm./min., Rx is the rate of tubular re-absorption of x mgm./min., both being the values corresponding to the plasma level Px; and he has come to the conclusion that Tx is a function of the variables appearing on the right-hand side of (8). It would seem from the above discussion, however, that Tx is either itself a characteristic constant of the kidney, or a function of Tmx and F, as the case may be; but it is certainly independent of Px, the actual plasma concentration of x. Tx can, it is true, be calculated from Földi's formula, which involves Px, but the threshold is not a function of Px. We would clarify our point by a physical example: Boyle's law gives the equation of state for one mole of an ideal gas at constant temperature as

$$pV = \text{const.}, \quad (9)$$

where p is pressure and V is volume, and the constant is proportional to the absolute temperature. It is possible to calculate the constant from (9), but it cannot be said to be a function of the variables appearing in that equation. (8) is a precisely analogous equation between the variables Px, Rx and Fx, and the value of Tx is independent of the actual values of the variables, because it is constant for given values of Tmx and F.

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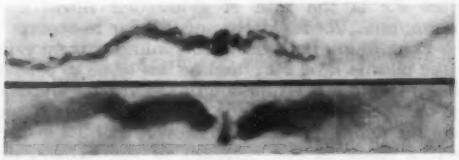
Nodes in the Central Nervous System

It is commonly stated that the nodes originally described by Ranvier[1], which are so characteristic a feature of peripheral nerve fibres, do not occur within the central nervous system. However, Ramón y Cajal, in his descriptions of those penetrating researches which have distinguished him as one of the foremost histologists of all time, refers repeatedly to *étranglements* or nodes on nerve fibres within the brain and spinal cord, and these are beautifully illustrated in some of his publications[2,3]. In spite of these observations, the absence of nodes in the central nervous system has often been assumed by some contemporary neurohistologists[4,5] and in many standard text-books of histology and neurology.

Recently, while examining several brains taken from rabbits injected intravenously with methylene blue, we have been able to confirm Ramón y Cajal's observations[4]. Deeply stained nodes, often associated with slight constrictions of the axis cylinder, have been found to be situated at intervals along tracts in many parts of the brain. Their morphological details are similar to those of nodes in peripheral fibres, including in some cases well-defined bracelets and cementing disks (see photograph). They are particularly conspicuous in fibres undergoing early degeneration, in which the axoplasm is metachromatically stained purple while the nodes remain a deep blue-



Nodes of small and large fibres in the optic tract, stained by intravenous methylene blue. (× 1,240)

green colour. In the central nervous system, as in peripheral nerve fibres, bifurcation invariably takes place at nodes, but many nodes are found in other situations. We have since found that similar preparations have been obtained with Ranvier's silver method by the late Prof. Zimmermann[7] of Bern.

Electrophysiological investigations of peripheral nerves recently made by Huxley and Staempfli[8] and Tasaki[9] have indicated, contrary to earlier opinions, that nodes play an important part in the propagation of nerve impulses. One of the main arguments hitherto adduced against this view is the supposed absence of nodes in the central nervous system. It appears that this objection can no longer be tenable. It is not clear how precisely the nodes of central fibres correspond to those in the periphery, because of the replacement of the Schwann sheath by oligodendroglia in the brain and spinal cord. However, unless the mechanism of nervous conduction differs greatly in different localities, nodes in the brain and spinal cord may have considerable physiological significance.

By the aid of intravenous methylene blue and silver methods, the structure and the distribution of nodes are now being studied with the view of obtaining anatomical data, for example, on the length of internodal segments, which have been pointed out[6] as relevant to the possible physiological role of node formations in the central nervous system.

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A Rare Species of Mysid from the Plymouth Area

When my husband, the late Prof. W. M. Tattersall, was examining material collected in the Plymouth area for his work on "The Seasonal Occurrence of Mysids off Plymouth"[1], he found a single adult male specimen from St. *L.*4 belonging to the genus *Heteromysis*. At that time only one species of this genus had been recorded from British waters, namely, *Heteromysis formosa* S. I. Smith. This species, though rare, had been recorded occasionally from Plymouth[2], the Channel Islands and from Scottish and Irish waters. As the male from Plymouth was undoubtedly a *Heteromysis*, it was not examined in detail but was recorded as *H. formosa*.

Shortly before his death in 1943, my husband had occasion to re-examine some of the Plymouth material, and found to his astonishment that the specimen he had recorded as *H. formosa* belonged to the much rarer *H. microps* (G. O. Sars)[3]. Sars first recorded his species under the generic name *Chiromysis*—"the mysis with a hand"—because of the very peculiar prehensile termination of the endopod of the third thoracic limb (= Sars's first leg). His material consisted of a few females only, from the Tunisian Gulf of Goletta, in 6–8 fathoms. Sars at the time was not aware that his new genus had already been described under the name of *Heteromysis* by S. I. Smith[4], who first recorded *Heteromysis formosa* from the North American side of the Atlantic, and he later withdrew the name *Chiromysis* in favour of the earlier *Heteromysis*[5].

Since Sars's original record of *H. microps* the species had never been recorded, nor had the male ever been seen until the specimen from Plymouth was taken. It was my husband's intention to publish a description of this unique specimen and, under his supervision, I made drawings of it. It agrees in the most minute detail with Sars's description and figures as regards general form, eyes, antennal scale, uropods and telson. The endopod of the third thoracic limb has the peculiar prehensile form which is the outstanding character of the genus, but in this specimen it is much more robust than in the female as figured by Sars. This is in all probability a sexual character.

In the hope of finding additional specimens of this interesting mysid, I recently spent some time at the Marine Laboratory, Plymouth, where, by kind permission of the director, Mr. F. S. Russell, I examined collections made in the neighbourhood of the original capture. Unfortunately, no other specimens of the species was obtained. A full description of the male, with figures, will be published shortly in a forthcoming Ray Society Monograph on the British Mysidacea.

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Pendeen, Heoldon,
Whitchurch, Glam.

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Photosynthesis in the Ears of Five Varieties of Wheat

In view of the observations of Knowles and Watkin[1], and of Watson and Norman[2], working with wheat and barley respectively, that about one-third of the final dry weight of the plant is added during the post-ear emergence period, the assimilation by the plant during this period merits special consideration as a factor in determining final yield. The concept of the net assimilation-rate, as originally proposed by Gregory[3], and so successfully used by him and others[4–6] in interpreting problems of crop-growth, would thus appear to require reconsideration, since the net assimilation-rate is usually estimated up to the stage of maximum leaf-growth. After this stage the proportion of green-leaf surface to that of other

	N.P. 710* *v1*	*N.P.* 165* *v2*	Punjab 9*D* *v3*	Agra Local *v4*	*N.P.* 735* *v5*	Significant differences at 5 per cent level
Days from sowing to anthesis	97	93	101	101	136	
Mean percentage contribution to grain-weight by assimilation in the ear	43·3 ± 3·31	15·3 ± 3·99	23·2 ± 3·45	23·9 ± 3·78	59·4 ± 3·31	*v1* and *v5* > *v2*, *v3*, *v4* *v2* = *v3* = *v4* *v5* > *v1*
Mean percentage contribution to total dry weight by assimilation in the ear	20·3 ± 1·57	7·5 ± 1·99	12·3 ± 1·77	12·3 ± 1·95	20·4 ± 1·19	*v1* and *v5* > *v2*, *v3*, *v4* *v2* = *v3* = *v4*
Mean percentage contribution to total dry weight by green leaf	16·9 ± 1·14	24·7 ± 2·33	18·1 ± 1·65	20·9 ± 2·00	18·7 ± 2·16	*v2* > *v1*, *v3* = *v4*, *v5*
Mean percentage reduction in grain number per spikelet due to shading of ear	19·5 ± 1·36	10·6 ± 3·65	15·4 ± 2·02	12·4 ± 3·51	37·3 ± 2·44	*v5* > *v1*, *v2*, *v3*, *v4*. *v1* > *v2* *v1* = *v3* = *v4*
Mean percentage reduction in grain number per spikelet due to defoliation	9·1 ± 1·64	14·1 ± 2·88	9·4 ± 1·00	10·0 ± 2·42	18·7 ± 3·08	*v5* > *v1*, *v3*, *v4* *v5* = *v2* *v1* = *v2* = *v3* = *v4*
Mean percentage reduction in 1,000 grain-weight due to shading of ear	19·1 ± 2·53	6·9 ± 2·12	3·9 ± 1·29	12·4 ± 1·00	42·9 ± 5·0	*v1* and *v5* > *v2*, *v3*, *v4* *v5* > *v1* *v4* > *v2*, *v3*
Mean percentage reduction in 1,000 grain-weight due to defoliation	11·4 ± 1·94	13·9 ± 1·95	10·4 ± 1·66	14·4 ± 1·42	7·7 ± 2·07	*v1* = *v2* = *v3* = *v4*. *v2* and *v4* > *v5* *v1* = *v3* = *v5*

* *N.P.* stands for New Pusa, formerly designated Pusa and Imperial Pusa, *P* and *I.P.*, respectively.

green parts diminishes appreciably with time, and the assimilation by the latter might be expected to contribute substantially to ultimate dry matter output. In fact, Boonstra[7], Smith[8], Watson and Norman[2] and Archbold[9] found that, in cereals, assimilation by the stems and by the ears themselves contribute substantially to grain yield.

In the course of work on the physiological analysis of factors determining yield, we have investigated possible varietal differences in respect of the contribution made by assimilation in the ear to grain-yield in wheat. The technique adopted was more or less similar to that of Watson and Norman[3]. The experiment comprised four treatments, namely, control, defoliation (removal of green leaf blades after anthesis), shading the ear and a combination of the last two. All four treatments were included in each pot, there being two shoots per treatment. There were ten replications of each treatment. The calculations were made on the lines adopted by Watson and Norman[3]. From the data presented in the accompanying table, it is concluded that: (*a*) assimilation in the ear contributes considerably more to grain-yield and total plant-weight in *N.P.* 735 and *N.P.* 710 than in the other three varieties; (*b*) the leaf and the ear contribute to total dry weight to the same extent in *N.P.* 710 and *N.P.* 735, whereas in the case of the other three varieties the leaf contributes more to the total dry weight; (*c*) in *N.P.* 165 the contribution of the leaf to total dry weight was, on the whole, the largest; (*d*) as a result of shading the ear, the reduction in 1,000 grain-weight correlated, on the whole, better than reduction in grain-number per spikelet with the differences in assimilation in the ear, which indicates that processes connected with seed setting (fertilization, embryo development, etc.) are not specifically affected; in fact, defoliation also affected seed setting.

It was observed in an investigation on the comparative performances of several varieties of wheat that *N.P.* 710 yielded better than the other three early varieties, *N.P.* 165, Punjab 9*D* and Agra Local, under restricted soil moisture. It is a matter of general observation that *N.P.* 710 and *N.P.* 735 are fairly resistant to black rust, whereas Agra Local and Punjab 9*D* are susceptible, and *N.P.* 165 is only moderately resistant.

It would appear that a variety with ears of high assimilatory capacity would perform relatively better in an adverse environment.

Further investigations are being carried out. Our thanks are due to Dr. B. P. Pal, head of the Division of Botany, for suggesting the choice of varieties and for encouragement.

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Oxygen Uptake of *Asterias* Embryos Before Hatching

Sea-urchins and starfishes differ principally in the oxygen uptake of oocytes and unfertilized eggs[1]; in sea-urchins the respiration of oocytes is higher than that of the eggs, whereas in starfishes the primary oocytes have a much lower oxygen consumption than have the secondary ones or the eggs. In addition, the great increase in oxygen consumption upon fertilization in the sea-urchin egg does not occur in the starfish egg[1–5]. These facts strongly suggest differences in the mechanism of oxidative substrate utilization between the unfertilized eggs of the two groups.

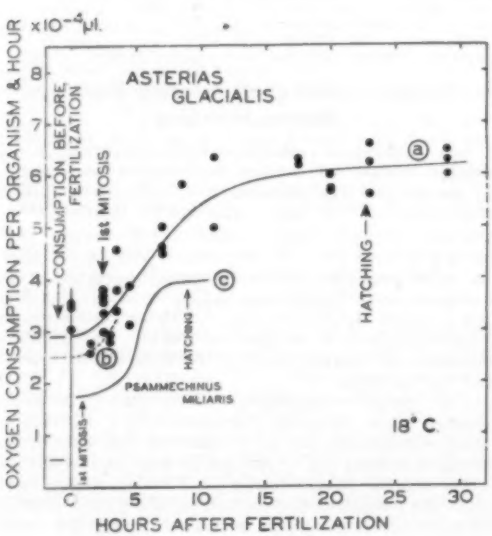
The oxygen consumption of the newly fertilized starfish egg is, however, if measured on a cell-volume basis, remarkably low in comparison with that of the newly fertilized egg of the sea-urchin[1] and of several other marine invertebrates[6]. Thus it might seem that the oxidative mechanism of the young starfish embryo differs from that of the sea-urchin. Probably

such a difference would manifest itself in fundamental divergences from the oxygen consumption pattern of the young sea-urchin embryo. Using Cartesian diver micro-respiration technique, the oxygen consumption of this latter has lately[1] been investigated for the time between fertilization and hatching (see also refs. 7, 8).

It has also recently been shown[1] that the exponential increase in oxygen uptake, characteristic of the first few hours of development in the sea-urchin egg[2,1], is roughly applicable to the same time interval in the starfish egg. During this time the starfish egg only passes the first mitosis, whereas the sea-urchin egg reaches the 8- or 16-cell stage. In the present investigation the starfish embryo respiration has been followed for some six hours after hatching.

As previously, Cartesian diver micro-respiration technique at 18° C. was used. In 0·8 µl. of sea-water (32 pro mille salinity) were placed ten eggs or embryos of *Asterias glacialis*, giving pressure differences of approximately 1 cm. per hour. Before fertilization the oocytes were given time to change into unfertilized eggs, that is, time to give off the polar bodies. In *Psammechinus miliaris*, where development to hatching is completed at 18° C. in nine hours, the embryos may, without developmental disturbances, remain inside the diver during the whole of this period. In *Asterias glacialis*, hatching at 18° C. is not completed until 23 hours after fertilization[1]. Moreover, eggs and embryos begin to show signs of dark cytolysis if kept inside the diver for more than five or six hours and simultaneously cease to increase their oxygen uptake rate. Thus divers have to be charged for short-time experiments (not exceeding four to five hours) with material of the different developmental stages, derived from spare cultures maintained at 18° C.

The results are given in the accompanying figure, where each point stands for the mean oxygen uptake of one experiment lasting four to five hours. Uptake before fertilization is denoted, as are the times of hatching and first mitosis (telophase). Curve *a* summarizes the results. In 1947 the uptake values in early development[1] were somewhat lower, as seen from curve *b*. For comparison the corresponding curve for *Psammechinus miliaris* is given in curve *c*.



The method of measurement used necessarily means that biological scattering has greater influence than in the corresponding experiments on *Psammechinus*, where the same embryos could be used throughout[1]. The results obtained, however, undoubtedly show that the increase in oxygen consumption between fertilization and hatching is principally of the same type in both *Asterias* and *Psammechinus*. Thus the results do not indicate that the oxidative mechanism of the young starfish embryo differs from that of the sea-urchin; instead, differences may be anticipated in the oxidative mechanisms of the unfertilized eggs of the two groups.

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Cotton Crop Yield in Relation to the Application of Fertilizers

THE authors of a letter under this title which appeared in *Nature* of March 5, p. 362, seem to be unaware how much is known about the manuring of Egypt's chief crop, and about the soil in which it grows.

The Chemical Section of the Ministry of Agriculture is close to the Faculty of Agriculture from which the authors write, and has published a notable and exhaustive series of official bulletins. Most of these are based upon ten-year runs of field experiments at twenty to thirty different sites each year. A list of those available on my shelves is appended.

This work is almost unknown to agricultural scientists elsewhere (having been published locally) and apparently in Egypt also. My present purpose is to direct attention to these comprehensive contributions to soil science which my former colleagues have made.

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LEAD ISOTOPES AND THE AGE OF THE EARTH

By Prof. ARTHUR HOLMES, F.R.S.

In his recent discussion of this subject, Prof. Harold Jeffreys[1] suggests two statistical methods for estimating t_0, the age of the earth's crust, from the data on the isotopic constitution of ore-leads of different ages, t_m, provided by Nier and his co-workers[2]. The first of these methods is wrong in principle and yields results which are internally inconsistent and widely at variance both with my own solutions[3,4] and with known geochemical data. The second is sound in principle and leads to results consistent with mine; but it is wrongly stated by Jeffreys, and the solitary example given is arithmetically incorrect. Jeffreys concludes "that no reliance can be placed on estimates of t_0 that depend on the abundance of Pb^{207}". Since my own estimate depends on the abundances of Pb^{206} and Pb^{207} and I can find no reason for modifying it, it becomes necessary to point out how the alleged discrepancies have arisen.

The atomic abundances of the lead isotopes determined by Nier being nearly what they would be if the primeval lead of the earth's crust had been slowly modified by radiogenic additions[5], it is assumed: (*a*) that a sample of lead separated from an ore of age t_m represents a sample of the rock-lead dispersed at the time of ore formation through the part of the crust from which rock-lead was extracted and concentrated into ore; (*b*) that the isotopic constitution of the primeval lead was constant at the time t_0, when the sialic material of the crust first separated from the body of the earth; the initial atomic abundances of $Pb^{204, 206, 207, 208}$ being 1, x_0, y_0, z_0* respectively; and (*c*) that the corresponding atomic abundances, 1, x_m, y_m, z_m, of the isotopes in a sample of ore-lead of age t_m are given by

$$x_m = x_0 + u\,(e^{\lambda_1 t_0} - e^{\lambda_1 t_m}) \quad (1)$$

$$y_m = y_0 + v\,(e^{\lambda_2 t_0} - e^{\lambda_2 t_m}) \quad (2)$$

$$z_m = z_0 + w\,(e^{\lambda_3 t_0} - e^{\lambda_3 t_m}), \quad (3)$$

where u, v and w are the present atomic abundances (relative to $Pb^{204} = 1$) of U^{238}, U^{235} and Th^{232} in the rock material from which the rock-lead was extracted to form ore-lead; and λ_1, λ_2 and λ_3 are the respective disintegration constants.

From (1) and (2), we have

$$\frac{x_m - x_0}{y_m - y_0} = \frac{139\,(e^{\lambda_1 t_0} - e^{\lambda_1 t_m})}{(e^{\lambda_2 t_0} - e^{\lambda_2 t_m})} = \frac{1}{r}. \quad (4)$$

Using the relevant data of Table 1 in sets of four, I obtained the following modal solution[4,6]:

x_0	y_0	t_0
10·945	13·51	3,350 m.y. (± about 8–10 per cent).

Shortly afterwards, Houtermans[7] independently published an approximate solution based on the same assumptions, but with somewhat different values for t_m. Since the content of uranium in rocks is generally variable from one region to another, x_m and y_m are also variable in ores of the same age from different regions. If all the assumptions were strictly correct, a plot of x_m against y_m for ores of a given age t_m should be linear, the resulting straight line being what Houtermans calls the 'isochron' for t_m. Two such isochrons for, say, Tertiary–Carboniferous and Pre-Cambrian ores, intersect at a point of which the co-ordinates are x_0 and y_0. Having graphically estimated x_0 and y_0 in this way, Houtermans then calculates t_0 from equation (4). His results are:

x_0	y_0	t_0
11·52 ± 0·60	14·03 ± 0·20	2,900 ± 300 m.y.

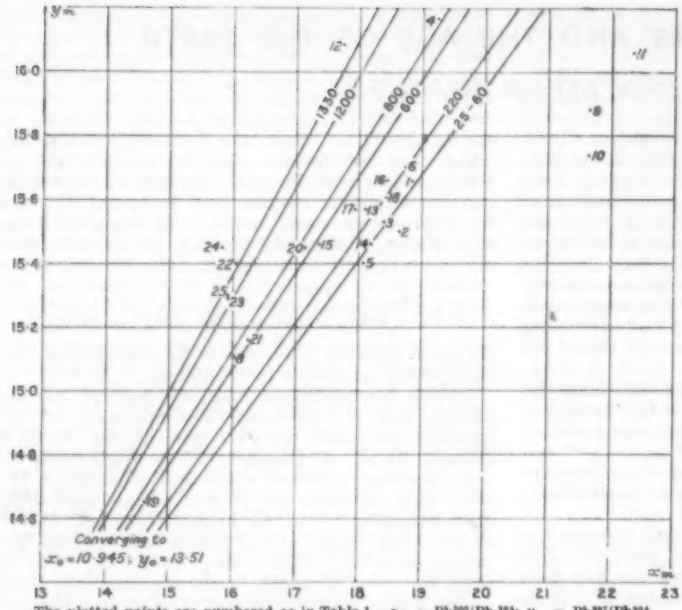
No great accuracy is attainable by this method, but the general agreement is of interest.

In the accompanying diagram, x_m and y_m are plotted and the isochrons (corresponding to my solution) are drawn from the point x_0, y_0, which is common to all. The tangent of the angle made by each isochron with the x-axis is r of equation (4), when both variables are plotted to the same scale, and is therefore $5r$ in the present diagram. It will be seen that many of the points fall near the isochrons on which, ideally, they should lie. Few of them, however, fit exactly, and some, especially those of the Joplin leads 9, 10 and 11, and the Austrian lead, 12, are very widely scattered. The existence of such serious departures from the linear relationship demonstrates that in some cases assumption (*c*) does not hold even approximately. This is, of course, only to be expected from a geological point of view. The assumption implies ideal conditions that are unlikely ever to have been realized in the history of any part of the crust. Every region from which lead ores have come must have passed through at least one orogenic cycle, and each time the rock material concerned passed from one cycle to the next—by way of such processes as denudation, sedimentation, metamorphism and granitization—there would be changes in the uranium–lead and thorium–lead ratios. The rather scanty geochemical data available

Table 1

Sample No.	Observed atomic abundances (Nier[2])			Age of ore t_m (m.y.)	Calculated atomic abundances (see text)		
	x_m	y_m	z_m		u	$v \times 10^3$	u/v
1	18·85	15·66	38·63	25	11·97	8·63	139
2	18·67	15·45	38·15	25	11·70	7·78	150
3	18·40	15·53	38·1	25	11·25	8·10	139
4	19·22	16·17	39·15	?			
5	18·07	15·40	38·0	25	10·79	7·58	142
6	18·71	15·70	38·5	25	11·76	8·79	134
7	19·30	15·73	39·5	60	12·76	8·92	143
8	16·04	15·11	35·26	?			
9	21·65	15·88	40·8	100	16·44	9·54	172
10	21·65	15·74	40·36	100	16·44	8·97	183
11	22·38	16·15	41·63	100	17·56	10·62	165
9, 10, 11	*21·89*	*15·92*	*40·93*	*100*	*16·81*	*9·71*	*173*
12	17·75	16·21	38·05	175	10·70	10·90	98
13	18·10	15·57	37·85	220	11·36	8·34	136
14	18·20	15·46	37·7	220	11·52	7·89	146
15	17·36	15·46	37·38	220	10·18	7·89	129
16	18·46	15·66	38·6	220	11·93	8·70	137
17	17·95	15·57	37·9	220	11·12	8·34	133
18	18·43	15·61	38·2	220	11·88	8·50	140
19	14·65	14·65	34·48	600	6·53	4·72	138
20	17·15	15·45	36·53	800	11·27	8·09	139
21	16·27	15·16	35·60	800	9·96	6·94	144
22	16·07	15·40	35·5	1200	11·07	8·31	133
23	15·93	15·29	35·25	1200	10·77	7·83	138
24	15·83	15·45	35·60	?			
25	15·93	15·30	35·3	1330	11·36	8·02	142
Averages (omitting Nos. 9, 10, 11, 12)					11·07	7·97	139

* It should be noticed that Jeffreys[1] calls the original abundances 1, *a*, *b*, *c*, whereas I used these symbols for the abundances in ore-leads[3,4]. The symbols now adopted should avoid any possible confusion.



The plotted points are numbered as in Table 1. $x_m = Pb^{206}/Pb^{204}$; $y_m = Pb^{207}/Pb^{204}$. The diagonal lines are the isochrons for various values of t_m (in m.y.) with t_0 taken as 3,350 m.y.

suggests that generally such changes would be quite small and that decreases would be just as likely as increases. For uranium and thorium some of the evidence is collected in Table 2. The general effect of an increase of uranium relative to lead would be to increase Pb^{206} relative to Pb^{207} in the lead eventually evolved, and so to carry a point x_m, y_m to the right of the isochron; with relative decrease of uranium the point would fall to the left. Some slight scatter of the points, not only along the isochron but also on each side of it, is therefore to be expected, and that is, in fact, what we usually find. Locally, however, there might be very considerable changes, and the apparently erratic Joplin (9, 10, 11) and Austrian (12) leads probably illustrate the cumulative effects of one or more such changes. The isotopic constitution of the Joplin lead could have been reached in a great variety of ways, of which the following is an example: modification of x_0 and y_0 in a source-rock with $(u + v) = 10$ until 2,000 m.y. ago, followed by further modification in the transformed source-rock of a later cycle with $(u + v) = 23$ until the time of ore formation. The Austrian lead requires a change of the opposite kind; for example, a source with $(u + v) = 22$ up to, say, 2,500 m.y. ago followed by a transformed source with $(u + v) = 5{\cdot}5$. Alternatively, the Austrian lead may be a re-precipitation in Triassic times of an old lead ore of age 1,400 m.y. derived from a source with $(u + v)$ about 16·5.

Explanations of the above kinds are offered to account for what Jeffreys[1] refers to as "a disturbance affecting the values for Pb^{207} by $\pm$ 0·2 or so and not associated with the variation of Pb^{206}", and also in justification of my having excluded the Joplin and Austrian leads from my treatment of the problem. These samples, as the isochron diagram shows, do not even approximately conform to the requirements of assumption (c), and consequently no method of estimating t_0 in which they are considered can be expected to yield reliable or consistent results. It should be added that, pending further information, samples 4 and 8 must also be excluded because their age is uncertain. I originally followed the National Research Council Committee[8] in regarding them as Tertiary; but I find that the ore deposits from which they came occur in Pre-Cambrian rocks and may themselves be of Pre-Cambrian age. It seems likely that the 'abnormality' of their x_m/y_m values would largely disappear if their true geological age were known. I originally excluded the Franklin, N.J., sample (20) on the ground that its age could not be assessed. It can now be added to the 800 m.y. group of Pre-Cambrian leads, since it comes from an orogenic belt for which there are two age determinations of 770 and 860 m.y.

Jeffreys divides the samples into four age-groups (*A*, *B*, *C*, *D* of Table 3). No serious statistical discrepancy arises as a result of combining the Joplin lead with the Tertiary leads to form Group *A*, because the three Joplin leads are represented only by their average, and the effect of this is largely balanced by the inclusion in the same group of samples 4 and 8. But in Group *B* the Triassic Austrian lead (12) is combined with the late Carboniferous leads, and it is solely for this reason that Jeffreys finds a negative correlation coefficient for x_m and y_m in Group *B*. If the Austrian lead is omitted, as it should be (see Group *E*), the correlation coefficient for the Carboniferous leads is + 0·69.

Table 2. Uranium and thorium contents of granitic rocks (Senftle and Keevil[9])

Regions	Geological ages	No. of samples	U in p.p.m.	Th in p.p.m.	$\frac{Th}{U}$
1. All outside North America	Wide range	30	4·35	15·2	3·50
2. Ontario and Quebec	Pre-Cambrian	396	2·90	8·89	3·07
3. North-east coast	Mainly Palæozoic	123	4·98	19·8	3·98
4. Eastern States	Palæozoic and some Pre-Cambrian	143	3·40	11·0	3·24
5. Central States	Palæozoic and some Pre-Cambrian	76	3·52	13·1	3·72
6. South-western States	Wide range	50	4·20	13·3	3·17
7. Western States	Mainly Tertiary	52	3·10	11·1	3·58
8. Rocky Mountain States	Mainly Mesozoic	199	4·98	18·7	3·76
9. Central Canada	Old Pre-Cambrian	126	4·68	11·2	2·39
10. British Columbia and Alaska	Mesozoic – Tertiary	92	3·52	12·2	3·47
	Weighted averages		3·82	12·48	3·27

Table 3

Group	No. of samples	$x_m = Pb^{206}/Pb^{204}$ Mean	s_1	$y_m = Pb^{207}/Pb^{204}$ Mean	s_2	$\frac{s_2}{s_1}$	t_0 (m.y.)	Corr. coeff x_m, y_m	$z_m = Pb^{208}/Pb^{204}$ Mean	s_3	$\frac{s_3}{s_1}$
A: 1-8, (9, 10, 11)	9	18·79	1·43	15·63	0·29	0·203	2870	+0·77	38·47	1·43	1·000
B: 12-18	7	18·04	0·36	15·65	0·24	0·663	4700	−0·07	37·95	0·76	1·100
C: 19, 21	2	15·46	0·81	14·90	0·255	0·315	3380	—	35·04	0·56	0·691
D: 22, 23, 25	3	15·98	0·066	15·33	0·050	0·751	4600	—	35·35	0·108	1·636
E: 1, 2, 3, 5, 6, 7	6	18·67	0·38	15·58	0·13	0·342	3680	+0·82	38·48	0·508	1·337
F: 13-18	6	18·08	0·37	15·555	0·074	0·200	2770	+0·69	37·94	0·384	1·038
G: 19, 20, 21	3	16·02	1·03	15·09	0·34	0·330	3450	+0·99	35·54	0·838	0·814

The first method developed by Jeffreys is based on the application of the data for Groups *A*–*D* (here recalculated in Table 3) to equations (1)–(3). s_1, s_2 and s_3 are the respective standard deviations of the means of x_m, y_m and z_m for a given group; and σ_1, σ_2 and σ_3 are those of u, v and w. If the standard error of u is σ_1, that of x_m is $\sigma_1 (e^{\lambda_1 t_0} - e^{\lambda_1 t_m})$ according to Jeffreys. If this were true, then (omitting the standard error of s_1 itself, which does not affect my criticism) we could write:

$$s_1 = \sigma_1 (e^{\lambda_1 t_0} - e^{\lambda_1 t_m}), \qquad (5)$$

and similarly for s_2 and s_3. For each age-group there is such an equation, and Jeffreys solves these equations for σ_1 and t_0, and similarly for σ_2 and t_0, and σ_3 and t_0. The results, as given by Jeffreys, are:

$\log \sigma_1 = +1{\cdot}54 \pm 0{\cdot}26$; $t_0 = 1{,}250 \pm 170$ m.y.
$\log \sigma_2 = -2{\cdot}25 \pm 0{\cdot}33$; $t_0 = 1{,}390 \pm 170$ m.y.
$\log \sigma_3 = +2{\cdot}54 \pm 0{\cdot}26$; $t_0 = 1{,}430 \pm 180$ m.y.

From this it appears that

$$\sigma_1 \text{ is about } 34{\cdot}7; \ \sigma_2 \text{ is about } 0{\cdot}0056; \ \sigma_3 \text{ is about } 347. \qquad (6)$$

Equation (5), however, would be true only if σ_1 referred to the same group as s_1, whereas in solving the equations it is assumed that σ_1 is the same for all four groups. Actually σ_1 is variable from group to group, just as s_1 is. This can be illustrated from the estimates of u listed in Table 1, calculated from equation (1) with $t_0 = 3{,}350$ m.y. The respective values of σ_1 for groups *A*, *B*, *C* and *D* are found to be 2·21, 0·59, 1·71 and 0·57.

From the data summarized in Table 2 it is possible to estimate at least the order of the real values of σ_1, σ_2 and σ_3 for the variation of uranium and thorium in granitic rocks. To transform parts per million of uranium and thorium into atomic abundances relative to $Pb^{204} = 1$, the average content of lead (207·2) in granitic rocks may be taken as 21 p.p.m. and the average total abundances as 74. $Pb^{204} = 1$ thus corresponds to 0·28 p.p.m. of Pb^{204}. Allowing for atomic weights, we find:

$$\left.\begin{aligned} U &= 3{\cdot}82 \text{ p.p.m.} \equiv u = 11{\cdot}61 \text{ and } v = 0{\cdot}08 \\ Th &= 12{\cdot}48 \text{ p.p.m.} \equiv w = 39{\cdot}19 \end{aligned}\right\} \qquad (7)$$

These results for u and v agree closely with those calculated from my solution in Table 1.

The standard deviations of the amounts of uranium and thorium in granites (data of Table 2) are 0·86 and 3·97 in p.p.m., corresponding to:

$$\sigma_1 = 2{\cdot}61; \quad \sigma_2 = 0{\cdot}019; \quad \sigma_3 = 12{\cdot}68.$$

Variation in the lead content of granites is not likely to increase these estimates, but rather to decrease them, since the elements concerned tend to vary sympathetically in rocks. If, as is probably the case, the ratio of uranium to lead varies less than uranium, and of thorium to lead less than thorium, then the above estimates for σ, etc., would be too high.

It will be seen that the values arrived at by Jeffreys for σ_1 and σ_3 in (6) are not only very much higher than the probable values, but are actually higher than the values of u and w, of which they purport to be the standard deviations. Even allowing for the errors introduced by ignoring the variation of σ_1, etc., from group to group, I find it impossible to understand how the values in (6) can have been extracted from the original data. My own results (cf. 7 and Table 1) are consistent with geochemical data, whereas those of Jeffreys are not. My results (Table 1) give $u/v = 139$, which is the accepted value, but Jeffreys finds $\sigma_1/\sigma_2 = 6{,}160$. Moreover, the results given by Jeffreys for σ_1, etc., and t_0 are internally inconsistent. If the figures in (6) are used to calculate t_0 from equations such as (5), the following results (in m.y.) are obtained:

	$\sigma_1 = 34{\cdot}7$	$\sigma_2 = 0{\cdot}0056$	$\sigma_3 = 347$
Group *A*	320	4,150	120
Group *B*	270	3,900	240
Group *C*	770	3,980	750
Group *D*	1,350	2,570	1,270

whereas Jeffreys gives the following figures for t_0:

$$1{,}250 \pm 170 \quad 1{,}390 \pm 170 \quad 1{,}430 \pm 180$$

I can only conclude that this method is not only wrong in its assumption of a constant σ_1, etc., but that a serious slip has probably been made in the working.

The second method suggested by Jeffreys for finding t_0 is essentially the Houtermans[7] isochron method treated statistically, instead of graphically. From equation (4) we can write:

$$s_1/s_2 = 139 (e^{\lambda_1 t_0} - e^{\lambda_1 t_m})/(e^{\lambda_2 t_0} - e^{\lambda_2 t_m}). \qquad (8)$$

Jeffreys, in his equation (7), writes, "$\log s_1 - \log s_2$" for s_1/s_2, but this is evidently a slip. Unfortunately, Jeffreys applies this method to Group *A* only and gives $t_0 = 4{,}000 \pm 370$ m.y. as the solution, whereas the correct value is $t_0 = 2{,}870$ m.y. $\pm$ about 10 per cent. In Table 3 I have applied the method to groups *A*–*D* and also to groups *E*, *F* and *G*, from which the 'abnormal' samples and those of uncertain age have been omitted. It will be seen that the average value of t_0 for *E*, *F* and *G* is 3,300 m.y., which agrees closely with my estimate[4] of 3,350 m.y. If the result from Group *D* were also included, the average t_0 would become higher, but Group *D* is not a satisfactory one for the application of this method, because the lead samples concerned have almost identical isotopic constitutions.

Jeffreys writes, "If we accept the smaller values of t_0, or indeed of any value less than 3,000 m.y., the variation of Pb^{207} as between ores of the same age is greater than we should expect from the variation of Pb^{206}". This statement clearly favours a value of t_0 above 3,000 m.y. But Jeffreys continues, "On the other hand, if we adopt a value near 4,000 m.y., we have no explanation of the small scatter of the values for the three oldest ores" (Group *D*). Surely, however, the small scatter is purely a matter of

chance and calls for no other explanation. Only two localities are involved, samples 22 and 23 being from Broken Hill, N.S.W., and sample 25 from Great Bear Lake, Canada, and there would be nothing remarkable in the granitic rocks of two such areas having nearly the same uranium, thorium and lead contents. The objection raised by Jeffreys to an age near 4,000 m.y. would be valid only if Group *D* were represented by samples from many localities and still showed a small scatter. As it is, the objection has no weight. Indeed, Jeffreys himself in his final paragraph says it is quite probable "that the small scatter . . . is an accidental agreement". These reasons against the use of Group *D* in this particular method do not apply to my original treatment, because there the data for the Group *D* samples were combined, not with each other, but with those for the samples belonging to groups *E*, *F* and *G*. The method I devised is admittedly a long and tedious one, but it has the advantage of giving a most probable solution, based on all the relevant data, not only for t_0, but also for x_0 and y_0. Meanwhile, I can at least agree with Jeffreys that many more isotopic analyses of old leads would be necessary to improve the estimate appreciably.

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[2] Nier, A. O., *J. Amer. Chem. Soc.*, **60**, 1571 (1938). Nier, A. O., Thompson, R. W., and Murphey, B. F., *Phys. Rev.*, **60**, 112 (1941).
[3] Holmes, A., *Nature*, **157**, 680 (1946).
[4] Holmes, A., *Nature*, **159**, 127 (1947).
[5] Holmes, A., *Geol. Mag.*, **84**, 123 (1947).
[6] Holmes, A., *Endeavour*, **6**, 99 (1947).
[7] Houtermans, F. G., *Z. Naturforsch.*, **2a**, 322 (1947).
[8] Report of the Committee on the Measurement of Geologic Time for 1940–41, N.R.C., Washington, 59 (1941).
[9] Senftle, F. E., and Keevil, N. P., *Trans. Amer. Geophys. Union*, **28**, 732 (1947).

MARINE BIOLOGY AT PLYMOUTH

THE latest issue (vol. 27, No. 3) of the *Journal of the Marine Biological Association of the United Kingdom*, again a large publication, provides articles of interest for many tastes in marine biology. There are two papers on fisheries, five on worms, two on molluscs, one on tunicates and one on seaweeds.

Mr. G. A. Steven, writing on mackerel migrations, continues the work published by Mr. P. G. Corbin in 1947. He states the case for depth spawning in this fish, which explains the apparent anomaly that English Channel mackerel migrate *offshore* to an area west of the Scillies in spring, but North Sea mackerel move *inshore* to the deep waters off Norway. The spawning grounds are in both cases near the 100-fathom contour. After the spring spawning the shoals disperse, appear inshore round the southern coasts of Great Britain in the surface waters, and, as winter approaches, congregate on the sea floor in scattered localized areas where there are banks and gulleys.

Mr. P. G. Corbin contributes the ninth in the series "Seasonal Abundance of Young Fish" for the year 1947, and reports that the total of all species of young fish was the lowest yet recorded, "thus fully bearing out the observations of the incomplete year of 1946 and the deductions from the 1939–46 winter phosphate data".

Mr. D. P. Wilson describes the development of *Ophelia bicornis* after artificial fertilization, the first time that the larval development of any member of the family Opheliidæ has been observed. Of interest is the fact that a secretion from the four anal papillæ and the parapodial lobes enables the metamorphosing larva to adhere to solid objects, such as grains of sand. Mr. Wilson considers that the development of *Ophelia* is a typical one among polychætes; it is simple and unspecialized. In a second paper he describes experiments on the metamorphosing larva which indicate that the larva can spend several weeks searching for a suitable substratum on which to metamorphose. It prefers smooth, rounded grains of quartz, uniform in size, and will die if it cannot find conditions as near as possible to its natural habitat when adult. The stimulus to metamorphose is probably tactile, not chemical.

Miss Jean Hanson illustrates specific differences in the genera *Apomatus* and *Protula* by a study of the pattern of the superficial blood vessels on the ventral surface of the thorax, and as a result puts forward the view that *Apomatus* and *Protula* should be combined in one genus, and similarly *Salmacina* and *Filograna*; but she does not suggest which names should be retained.

A new Enchytræid from the beaches of North Wales is described by Helge O. Backlund of Sweden. It has been named *Lumbricillus reynoldsoni* after its discoverer, Dr. T. B. Reynoldson, of Bangor.

Another little-known life-history, that of *Arenicola marina*, has been ably demonstrated by Dr. G. E. Newell. Working on the Whitstable Flats, he collected worms at weekly intervals throughout the year, and found that spawning occurred between the new and full moon in the second half of October, the maximum being at the first quarter, or neap tide. Eggs and sperms were deposited on the surface of the sand at extreme low-water as thin films and milky puddles respectively. The trochophore is demersal, hatching in four or five days after fertilization. It inhabits the *Fucus* zone, and is therefore carried inshore on the tide. Next spring, after metamorphosis, it moves down the beach, and spawns for the first time when two years old. Many worms die after spawning. Discovery of the egg film and autumn spawning settle two questions that have worried marine zoologists for many years.

Prof. C. M. Yonge continues his studies on the structure and function of the mantle cavity in the Mollusca by an account of a shallow burrowing lamellibranch, *Spisula subtruncata*, and a deep-burrowing one, *Lutraria lutraria*. In the former, which inhabits silty sand, the fourth pallial opening for the removal of waste matter from the pallial cavity, just anterior to the inhalant siphon, is provided by slight divergence mid-ventrally of the otherwise closely apposed mantle folds. Long frontal cilia on the gills and a siphonal valve on the inhalant aperture assist in the cleansing operation. In *Lutraria*, a member of the same family, there is a similar waste canal, but the long frontal cilia and siphonal valve are absent.

Dr. Vera Fretter has investigated some of the minute prosobranchs of rock pools, *Skeneopsis planorbis*, *Omalogyra atomus*, *Rissoella diaphana* and *R. opalina*. In their adaptation to a rock-pool habitat these four molluscs have become highly specialized. The ctenidium and osphradium are reduced in *Skeneopsis* and absent in the other genera, the gut is simple, and the reproductive organs are complex. *Omalogyra* and *Rissoella* are hermaphrodite. The young, hatched from egg capsules in two weeks, crawl about, become mature in six weeks, and reproduce in the same season. All are herbivorous, but assimilate only the cell contents of the plants they

consume. They anchor themselves by a mucous rope paid out from the posterior pedal gland. This is an interesting paper with handsome illustrations.

Prof. N. J. Berrill has studied two colonial ascidians, *Stolonica socialis* and *Distomus variolosus*, and as a result considers that the botryllids and the polystelid section of the Styelidæ "exhibiting palleal budding, comprise a natural group". These also are the only ascidians with a photolith, responsive both to light and gravity, in the tadpole phase. He suggests, therefore, a family Styelidæ, with subfamilies Botryllinæ and Styelinæ. But the position of *Polycarpa* and other simple Styelids is still obscure.

A welcome new feature is the first of a promised series on algæ. Dr. Mary Parke, commencing with the family Laminariaceæ, writes on the growth of *Laminaria saccharina* from the Devon and Argyll coasts. Her investigations prove that the minute gametophyte is capable of reproduction throughout the year, although the bathymetric level and habitat control its fertility. Sporophytes develop at low levels in spring, summer and autumn, but at higher levels in winter, early spring, late summer and autumn. They can live three years under suitable conditions, with more rapid growth-periods in the first half of each year. The distal frond tissue is cast continuously. Sporophytes first reach maturity at the end of their first year. Dr. Parke is making a type collection of seaweeds from the Plymouth area.

That the Plymouth Laboratory is flourishing is shown by the impressive list of researches now being carried out, by the names of the distinguished visitors who come to it from all parts of the world, and, perhaps not least, by the 83,000 local visitors attracted to the aquarium. The number of members of the Association, however, shows only a slight increase, and might be augmented, with benefit both to the members and to the Laboratory.

Dr. F. S. Russell's lecture on the Plymouth Laboratory, delivered to the Royal Society in March 1947, has been reprinted in the *Journal*, and provides very interesting reading. Both it and the photographs make every marine biologist long to go down to the sea again.

N. B. Eales

UNITED NATIONS EDUCATIONAL, SCIENTIFIC AND CULTURAL ORGANISATION*

THE detailed report of the Director General of the United Nations Educational, Scientific and Cultural Organisation on the activities of the Organisation in 1948 could with advantage have been provided with an index, as heads under which the information is supplied—reconstruction, communications, education, cultural interchange, human and social relations, natural sciences—overlap and are not those under which information is necessarily sought. The work of the library, for example, is described under both the first two headings, while much that is of direct interest to scientific workers is scattered under other headings than that of natural sciences. For example, the emergency action taken to deal with the needs of war-devastated countries for books, educational material, and scientific and technical equipment, including the Scientific Equipment Scheme, is described under "Reconstruction", which also records the issue of the second volume of the "Book of Needs", covering surveys mainly in South Asia and the Far East and in Malta, with an appendix including new data on needs in European countries. The international fellowship programmes are described under "Communications". Forty-eight fellowships were awarded at Mexico City in November 1947 in the following fields: science and social development; cinema and radio education; educational problems of war-affected children; librarianship; educational administration; and art and music education. Six fellowships, one in each subject, have been allocated to China, Czechoslovakia, Greece, the Netherlands, Norway, Poland, Denmark and the Philippines.

In accordance with the recommendations of a committee of nine experts from Czechoslovakia, France, the Netherlands, Sweden, the United Kingdom and the United States of America, an International Conference on Scientific Abstracting is projected for June 1949, and the International Federation for Documentation is making a survey of scientific abstracting services on behalf of Unesco. Publications exchange has also been considered, and an approach made to the delicate and complex problems of copyright. Besides the preparatory conference of representatives of universities at Utrecht last August, an interim committee has been set up to develop plans for an international association of universities and like institutions, including an International Universities Bureau. Under the museums programme, advice is being given to museums in member States on exhibitions available for international distribution and on those for which there would be an international demand if they were formed. Questions of methods in political science, the popularization of science and the social implications of science are also receiving attention, while the work of the Field Science Co-operation Offices in Rio de Janeiro, Cairo and Nanking is already proving very successful. Further reference is made to the work of the International Institute of the Hylean Amazon, and an International Conference on High Altitude Research Stations at Interlaken held during August 31–September 3 recommended the establishment by the International Council of Scientific Unions of a mixed commission to facilitate the exchange of information, and that existing high-altitude stations should be organised into a network with additional stations to be established. Besides participating in the preparations for the Scientific Conference on the Conservation and Utilization of Resources in 1949, the Organisation is convening a Technical Conference on the Protection of Nature to be held in June 1949 and has organised a European and African Technical Symposium for the preparatory study of certain regional problems.

Elsewhere, in his general survey, Dr. Huxley refers to the experimental scheme for book coupons covering six countries, to the international summer school for librarians, the creation of the Mass Communications Projects Division, to the need for careful thought on the policy of publications and sponsorship of international publishing activities, and to the importance of the population problem for the tasks of the Organisation.

* United Nations Educational, Scientific and Cultural Organisation. Report of the Director General on the Activities of the Organisation in 1948. (Unesco Publication 226.) Pp. 119. (Paris: Unesco, 1948.) 7s. net.

RAPKINE MEMORIAL MEETING

THE president of the Royal Society, Sir Robert Robinson, presided at a meeting held at the Society for Visiting Scientists on March 9, in memory of the late Louis Rapkine. The chief guests were the French Ambassador and Madame Sarah Rapkine. Mlle. A. Deloyers and Prof. Francis Perrin represented the Commissariat à l'Energie Atomique, and Dr. Magat the Centre National de la Recherche Scientifique; Dr. A. M. Lwoff of the Pasteur Institute, Prof. S. Mandelbrojt of the Collège de France, Prof. J. Hadamard and Dr. A. Mirlès also attended from France.

Sir Robert Robinson said that they had gathered together to give tribute to the memory of a great man whose work was not complete at the time that he died, and whose loss was therefore regretted the more poignantly. He welcomed the French Ambassador and Mme. Rapkine, and their French colleagues.

M. Massigli, speaking in French, said that he came to know Rapkine after he had joined the de Gaulle movement in London, and in his efforts to secure the escape of scientific men from France Rapkine accomplished a great work in fostering Anglo-French scientific relations.

Dr. Joseph Needham spoke of the earlier part of Rapkine's scientific life. He met him first in 1925 at the Marine Laboratory at Roscoff. Dr. Needham said that he and his wife, Dr. Dorothy Needham, were both profoundly influenced by their conversations with Rapkine. He had helped to emancipate them from the insularity of English cultural and social life. Dr. Needham remarked that France was the only country where a young man with Rapkine's unorthodox background could have secured a training in scientific research. His adoption of French nationality was a tribute to French civilization. Rapkine had an extraordinary quality of making people act and live up to the best that was in them. His piercing look made one feel as if one's own conscience was speaking to one, and yet he had such charm that no one ever took offence. His hero was Spinoza, who died at almost exactly the same age of forty-four.

Dr. Lwoff gave an account of the latter part of Rapkine's scientific researches. His early work had led him to the study of the chemical processes of cell division. Gowland Hopkins and Dixon had established that the reduction of oxidized glutathione by tissues occurs only in the presence of soluble sulphydryl groups. Rapkine postulated that cell division is preceded by protein denaturation, which is responsible for the free sulphydryl groups found in the egg. He confirmed these deductions by experiment, and found considerable increases in lactic acid production. He tried to inhibit reversibly the division of the egg. Dickens and Rapkine independently proved that the reaction between glutathione and mono-iodoacetic acid is stoichiometric. The inhibition of cell division by mono-iodoacetic acid was demonstrated in 1937. In the following year Gowland Hopkins discovered that the activity of succino-dehydrogenase is correlated with the presence of sulphydryl groups in the molecule. Independently, Rapkine prepared triosephosphate dehydrogenase and proved that the enzyme is inactivated by oxidized glutathione.

Out of this work came the crowning scientific discovery of his career, namely, the proof, together with Mme. Rapkine and Trpinac, of the protection by cozymase of the sulphydryl groups of dehydrases. In 1939, Gowland Hopkins, the master of British biochemistry, wrote: "His researches have thrown much light on the fundamental phenomena of cell division. They have shown the biological importance of sulphydryl groups. And, directly or indirectly, they have illuminated many other aspects of cell activity. His work is of fundamental importance."

In 1939 Rapkine resisted the temptation to follow up his brilliant researches, and accomplished his destiny by giving to his elected country, during the most tragic period of its history, seven years of a life which was to be so brief.

Prof. Francis Perrin recounted Rapkine's part in rescuing French scientific men after 1940, among whom were himself, and his father the late Jean Perrin, and of how he collected funds in America and found posts for them. He had only recently adopted French nationality, but his loyalty, foresight and moral conduct were an example to his new countrymen. He became the undisputed leader of the French scientific workers in exile, and was not only their chief but also their conscience. None of them would make any decision without his moral approbation.

Rapkine's work for refugees was described by Prof. A. V. Hill. Shortly after the formation of the Academic Assistance Council in Britain in 1933, a similar committee was formed in France. It met with the usual difficulties, and gradually ceased to function. In 1936, a new committee was formed on the initiative of Rapkine. Rapkine had the same difficulties as the earlier committee, and the legacy of its failure, but he overcame them. If he believed in a cause, no obstacle was unsurmountable for him. He had a horror of bureaucracy and a belief in vigorous direct action, qualities which were later to mean life and freedom for a large number of French scientific men and their families. Rapkine started the formation of the international Society for the Protection of Science and Learning, under the presidency of Niels Bohr. His faith, his endless compassion, his integrity and his extraordinary practical sense were an inspiration to all.

Prof. Hadamard referred to Rapkine's sacrifice of years of his scientific life, and the loss of his scientific future. Rapkine had told him after the War that he had devoted years of his life to the rescue of scientific men, and he now would return to science, and acquire—which he thought he could—a great and important scientific authority, and which he would then use for the assistance of great public causes.

Prof. Mandelbrojt described Rapkine's leadership of the French Scientific Mission. He had saved many French scientific workers from concentration camp and death, and had found work for them in America. But none were deeply satisfied. Their souls were not in America but with their colleagues in occupied France. They felt that others were fighting the war for them, and they had a deep desire to join in the fighting for liberation. Many tried to enlist in the army, but were too old or otherwise unsuitable. In 1943 Rapkine visited England and realized the importance for France of a knowledge of the new scientific methods developed during the War, especially of operational research and team-work. He returned to America, and mobilized his group to go to England to assist the British effort in these fields. It was a measure of Rapkine's character that the British authorities were willing to entrust such important new knowledge to him and anyone recommended by him; and so the French Scientific

Mission was able to bring to France at the earliest possible moment much new information on operational research, radar, aeronautics, nutrition and medical research, etc.

Prof. Mandelbrojt ended his address with a proposal for the foundation of an International Rapkine Memorial Fund consecrated to the solution of those problems in which Rapkine had been interested, and to which he had devoted his genius.

Dr. Magat described how in February 1941, when he left as a refugee for America, his state of mind was low, and the future uncertain. When he arrived, the first person he saw was Rapkine, and wherever anyone arrived Rapkine was there to meet them. "It is important," he said, "for them to feel that they are not alone here."

Prof. J. D. Bernal read an appreciation by Prof. P. M. S. Blackett, who had written that Rapkine, in setting up his Mission, had from the very beginning seen more clearly than others the real facts of the situation. He realized what could be achieved, and what not, and he laid his plans accordingly. But vision and intelligence alone would not have led him to the success he attained; what made this success possible were his gifts of character—such a combination of intelligence, persistence and charm, with first-class scientific ability, as are rarely found in one man.

Prof. Bernal added on his own behalf that Rapkine's personality and achievement had been taken too much for granted. We accepted him as part of the atmosphere and of the century. But, in fact, Rapkine was the pattern of the man on which the scientific world of the future will be based.

Mr. J. G. Crowther described how Rapkine joined at an early stage in the founding of the Society for Visiting Scientists. He was a foundation member of the Executive Committee, and the first assistant secretary. In the latter capacity, he was asked to search for a house, with the suggestion that one might be found in Old Burlington Street. Within twenty minutes he returned with news that the present premises of the Society were available and suitable. Mr. Crowther said that Rapkine was sometimes known among his friends as the 'Prophet'. That, indeed, was what he was: leading his people out of persecution, and by his character and example revealing to them the moral law.

Sir Robert Robinson, in concluding the proceedings, described the premature loss of Rapkine as irreparable, and one to be compared with that of Moseley in the First World War. He hoped in particular that Prof. Mandelbrojt's proposal of an International Rapkine Memorial Fund would be instituted.

SOLDERING

MR. W. R. LEWIS, development officer of the Tin Research Institute, recently gave the Institution of Electronics a review of the problem of soldering, particularly those aspects which have led to the continuous-belt technique of soldering articles together, or for making tin-plate boxes, when the mode of heating is with high-frequency currents generated by thermionic-valve plant. The union of metallic surfaces is greatly facilitated by previous 'tinning', that is to say, coating the juxtaposed surfaces with pure tin or a solder, either electrolytically or by hot-dipping; 'tinned' surfaces can be brought very close together and the space between, even if only a few thousandths of an inch, filled with solder, ingress being by capillary action. Thus the making of tin-plate boxes, in which the edges of the pieces are hooked or bumped together, entirely depends on this capillary action, using rings of solder wire, cored with the requisite flux.

The action of the flux is to remove the oxide film. Recent advances include many organic materials which, under the moderate temperatures prevalent in soldering, decompose and release acid, particularly hydrochloric acid, for cleaning the surface. Among these substances are oleic acid, abietic acid (already in resin or rosin), as well as the more frequently used ammonium and zinc chlorides. In the 'activated' fluxes the aim is to produce at the union just sufficient acid to remove the film, so that no appreciable acid is left to give rise to corrosion in damp atmospheres. The choice of flux depends on the metals to be joined, and some fluxes are better than others: for example, phosphoric acid for steel, copper and brass, and lactic acid for iron and brass. The problem with aluminium is to get the tin or solder into intimate contact with the base metal without the oxide film intervening, and this is frequently achieved by vigorous scratching. An alternative suggestion is to build up the oxide film by treatment with phosphoric acid and nitric acid so that it breaks away more easily; the flux then protects the base metal surface while it is being 'tinned' with a high-tin solder.

The art of soldering has been greatly enhanced by the standardized methods of testing solderability, such as the spreading test, the Schumacher–Bouton–Phipps twisted-wire test for capillarity, the Earle test developed in Great Britain during the War for recording the surface pulls across the solder on a kollagraph, and the war-time *D.T.D.* 599 specification. A word of warning must be noted, with respect to the difficulty of controlling the thickness of fine electro-plated films of 'tinning' when large batches of small articles are placed in the electrolytic bath; a considerable factor of safety should be used to ensure a universal minimum.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, March 21

FARMERS' CLUB (at the Royal Empire Society, Craven Street, Strand, London, W.C.2), at 2.30 p.m.—Prof. W. Ellison: "Reclamation and Use of Marginal Land".

PHYSICAL SOCIETY (at the Royal Institution, 21 Albemarle Street, London, W.1), at 5 p.m.—Prof. A. O. Rankine, F.R.S.: "Experimental Studies in Thermal Convection" (Guthrie Lecture).

RATIONALIST PRESS ASSOCIATION (at the Alliance Hall, Palace Street, London, S.W.1), at 7 p.m.—Dr. J. C. Flugel: "Psychology and the Problems of Peace". (Further Lectures on March 28 and April 4.)

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 8.15 p.m.—Mr. Eric Shipton: "Travels in Sinkiang".

Tuesday, March 22

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 5 p.m.—Dr. W. E. H. Stanner: "Sociological Problems of the Groundnut Scheme in Tanganyika".

EUGENICS SOCIETY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. J. C. Trevor: "Some Problems of Race".*

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENTS SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Magnetic Amplifiers" (to be opened by Mr. F. H. Belsey).

MANCHESTER GEOGRAPHICAL SOCIETY (in the Geographical Hall, St. Mary's Parsonage, Manchester), at 6.30 p.m.—Prof. L. Dudley Stamp: "Alaska".

INSTITUTION OF ELECTRICAL ENGINEERS, NORTH-WESTERN CENTRE (at the Engineers' Club, Albert Square, Manchester), at 7 p.m.—Dr. G. H. Tupling: "The Early Metal Trades and the Beginnings of Mechanical Engineering in Lancashire" (Fourth Annual University Lecture).

Wednesday, March 23

PHYSICAL SOCIETY, LOW TEMPERATURE GROUP (at Petrocarbon, Ltd., Eccles, Manchester), at 9.45 a.m.—Science Meeting.

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

SOCIETY OF CHEMICAL INDUSTRY, NUTRITION PANEL OF THE FOOD GROUP (at Gas Industry House, 1 Grosvenor Place, London, S.W.1), at 6.15 p.m.—Prof. J. Beattie: "The Effect of Non-Protein Calories on the Utilization of Proteins".

INSTITUTION OF ELECTRONICS, NORTH-WESTERN BRANCH (in the Reynolds Hall, College of Technology, Manchester), at 6.30 p.m.—Mr. S. Rodda: "Photo-Multipliers".

Thursday, March 24

PHYSICAL SOCIETY, OPTICAL GROUP (in the Physics Department, Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7), at 3 p.m.—Scientific Papers.

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Discussion on "Physics and Chemistry of Hydrocarbon Gels" (to be opened by Prof. E. K. Rideal, F.R.S.).

LINNEAN SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Discussion on "Animal and Plant Populations in Fresh Water" (to be opened by Dr. T. T. Macan and Mr. D. Le Cren).

INSTITUTE OF SOCIOLOGY (at the Royal Institute of British Architects, Portland Place, London, W.1), at 5.30 p.m.—Prof. T. H. Pear: "The Relations between Anthropology, Psychology and Sociology".

CHEMICAL SOCIETY, MANCHESTER SECTION (joint meeting with the ROYAL INSTITUTE OF CHEMISTRY and the SOCIETY OF CHEMICAL INDUSTRY, at the Engineers' Club, Albert Square, Manchester), at 6.45 p.m.—Prof. M. Stacey: "The Chemistry of the Deoxy-Sugars".

ROYAL INSTITUTE OF CHEMISTRY, LONDON AND S.E. COUNTIES SECTION (in the Material Research Laboratory, Philips Electrical, Ltd., New Road, Mitcham Junction), at 7.15 p.m.—Dr. J. S. Anderson: "The Chemistry of Semi-conducting Solids".

Friday, March 25

BIOCHEMICAL SOCIETY (in the Department of Biochemistry, University College, Gower Street, London, W.C.1), at 11 a.m.—Annual General Meeting: Scientific Papers.

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Geophysical Discussion.

MANCHESTER STATISTICAL SOCIETY, STATISTICAL METHODS STUDY GROUP (at the Textile Institute, 16 St. Mary's Parsonage, Manchester), at 5.30 p.m.—Mr. A. S. Wharton: "The Organisation of a Market Research Department".

MANCHESTER STATISTICAL SOCIETY, INDUSTRIAL GROUP (at the Textile Institute, 16 St. Mary's Parsonage, Manchester), at 6.45 p.m.—Mr. N. T. Gridgeman: "Applications of Statistical Methods in Biology".

SHEFFIELD METALLURGICAL ASSOCIATION, MODERN METHODS OF ANALYSIS GROUP (at 198 West Street, Sheffield), at 7 p.m.—Mr. J. H. Oldfield: "Solution Analysis by Emission Spectroscopy".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Prof. F. A. Paneth, F.R.S.: "Whence Comes Meteorites? Views Ancient and Modern".

Saturday, March 26

AMATEUR ENTOMOLOGISTS' SOCIETY (at Buckingham Gate Central Schools, Wilfred Street, London, S.W.1), at 2 p.m.—Exhibition of Entomological Specimens and Technique, and Lectures.*

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER or ASSISTANT LECTURER with qualifications in Pure Mathematics, a LECTURER or ASSISTANT LECTURER with qualifications in Applied Mathematics, and a RESEARCH ASSISTANT IN MATHEMATICAL STATISTICS—The Registrar, The University, Manchester 13 (March 25).

SENIOR ASSISTANT IN PHYSICS—The Clerk to the Governors, Mid-Essex Technical College and School of Art, Market Road, Chelmsford (March 26).

LABORATORY TECHNICIAN (male)—The Secretary, Institute of Ophthalmology, Judd Street, London, W.C.1 (March 26).

ASSISTANT PHYSICIST in the Department of Physics applied to Medicine—The Secretary, Middlesex Hospital Medical School, London, W.1 (March 26).

BIOCHEMIST to participate in biochemical studies of lactation involving the use of tracer isotopes, and a BIOCHEMIST or CHEMIST to assist in researches in biochemistry of lactation—The Secretary, National Institute for Research in Dairying, Shinfield, Reading (March 26).

LECTURER IN INORGANIC CHEMISTRY AND METALLURGY, a LECTURER IN BIOLOGY, and a LECTURER IN PHYSICS—The Principal, Acton Technical College, High Street, Acton, London, W.3 (March 26).

ASSISTANT IN THE SCIENCE GROUP OF DEPARTMENTS, London Headquarters (to establish and maintain contacts with all branches of the sciences and generally to promote the scientific activities of the Council overseas)—The Director, Personnel Department, British Council, 3 Hanover Street, London, W.1 (March 28).

TRAVELLING SCHOLARSHIP IN SANITARY SCIENCE OR MUNICIPAL ENGINEERING AND HYGIENE—The Clerk, Chadwick Trustees, 204 Abbey House, Westminster, London, S.W.1 (March 31).

SPECIALIST ADVISORY OFFICERS in soil chemistry, the chemistry of animal nutrition, entomology, plant pathology and bacteriology, ASSISTANTS for field and laboratory work, and CHEMISTS for analytical work on soils, feeding-stuffs and other agricultural materials—The Secretary, Ministry of Agriculture and Fisheries, 1–4 Cambridge Terrace, London, N.W.1, endorsed 'N.A.A.S.' (March 31; overseas, May 14).

RESEARCH FELLOWSHIP, and a RESEARCH ASSISTANT, IN THE DEPARTMENT OF ECONOMICS, University of Natal—The Secretary, Association of Universities of the British Commonwealth, 32 Woburn Square, London, W.C.1 (March 31).

RESEARCH ASSISTANT (to work under the direction of the research officer in bee-keeping) on field and laboratory problems relating to honeybees and their management—The Secretary, North of Scotland College of Agriculture, 41½ Union Street, Aberdeen (March 31).

SENIOR SCIENTIFIC OFFICER or SCIENTIFIC OFFICER as CHEMIST at the Marine Laboratory, Aberdeen, a SENIOR SCIENTIFIC OFFICER as CHEMIST at the Brown Trout Research Laboratory, Pitlochry, and a SCIENTIFIC OFFICER as BOTANIST at the Brown Trout Research Laboratory, Pitlochry—The Establishment Officer, Scottish Home Department, Room 364, St. Andrew's House, Edinburgh 1 (March 31).

SENIOR LECTURER IN AGRICULTURE, a LECTURER IN POULTRY HUSBANDRY, a LECTURER IN FARM MACHINERY AND IMPLEMENTS, and a LECTURER IN AGRICULTURAL SCIENCE, at the Shropshire Farm Institute, Walford, near Baschurch—The Secretary for Education, County Buildings, Shrewsbury (April 2).

PRINCIPAL SCIENTIFIC OFFICERS or SENIOR SCIENTIFIC OFFICERS (unestablished) for veterinary research posts at a Ministry of Supply Research and Development Establishment in Wilts—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting G.8/49A (April 2).

LECTURER or ASSISTANT LECTURER IN BOTANY with special qualifications in Taxonomy, and an ASSISTANT LECTURER IN ECONOMIC BOTANY with qualifications in Agriculture or Horticulture—The Registrar, The University, Manchester 13 (April 8).

DERBY CHAIR OF ZOOLOGY, and a DIRECTOR OF THE MARINE BIOLOGICAL STATION, Port Erin—The Registrar, The University, Liverpool (April 9).

PHYSICIST AT THE GEOPHYSICAL OBSERVATORY, Wellington—The Official Secretary, Office of the High Commissioner for New Zealand, 415 Strand, London, W.C.2 (April 15).

LECTURER IN CHILD PSYCHOLOGY—The Registrar, The University, Manchester 13 (April 15).

DEMONSTRATOR IN THE DEPARTMENT OF CHEMISTRY—The Secretary, Bedford College for Women, Regent's Park, London, N.W.1 (April 16).

LECTURER IN GEOLOGY—The Registrar, University College, Hull (April 19).

LECTURERS (2) IN MATHEMATICS—The Secretary, The University, Aberdeen (April 20).

INTERNATIONAL WOOL SECRETARIAT SCHOLARSHIPS—The Registrar, The University, Manchester 13 (April 30).

LECTURER or ASSISTANT LECTURER IN ZOOLOGY in the University College of the West Indies—The Secretary, Inter-University Council for Higher Education in the Colonies, 8 Park Street, London, W.1 (May 1).

DIRECTOR—The Chairman, Coconut Research Scheme, Lunuwila, Ceylon (May 11).

LECTURER IN THE MATHEMATICS DEPARTMENT—The Principal, Northampton Polytechnic, St. John Street, London, E.C.1.

TECHNICIAN (Grade B) with histological experience IN THE DEPARTMENT OF SURGERY—The Secretary, Marischal College, Aberdeen.

QUALIFIED TECHNICIAN or STUDENT TECHNICIAN IN THE BIOCHEMISTRY DEPARTMENT—The Secretary, St. Mary's Hospital Medical School, Paddington, London, W.2.

MEDICAL LABORATORY TECHNICIANS (2, one in the Bio-chemical Department and one for the Haematology and Clinical Pathology Department)—The Secretary, County Hospital, Lincoln.

SENIOR TECHNICIAN—The Regional Transfusion Officer, Southmead, Bristol.

MATHEMATICIAN (with a first-class honours degree and, preferably, some knowledge of the theory of elasticity) for research in applied mechanics—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1.

RESEARCH ASSISTANT (preferably with honours degree in zoology) for research laboratory—The Secretary, South Manchester Hospital Management Committee, Christie Hospital and Holt Radium Institute, Manchester 20.

STUDENTSHIPS IN PLANT BREEDING or ENTOMOLOGY—The Secretary, Empire Cotton Growing Corporation, 1a Harrington Road, London, S.W.7.

LECTURER IN PHYSICS AND MATHEMATICS at the Municipal Technical College—The Director of Education, Education Office, St. Helens.

TECHNICIAN at the High Tension Laboratory, Lahore, Pakistan—The Education Authority, High Commissioner for Pakistan, 14 Fitzhardinge Street, London, W.1.

LECTURER IN CHEMISTRY—The Principal, Derby Technical College, Normanton Road, Derby.

SENIOR LECTURER IN CHEMISTRY—The Clerk to the Governors, Chelsea Polytechnic, Manresa Road, London, S.W.3.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Management Abstracts. Vol. 1, No. 1, September 1948. Pp. 36. (London: British Institute of Management, 1948.) 3s.; annual subscription, 30s. [209

Agricultural Research Institute of Northern Ireland. Twenty-first Annual Report, 1947–48. Pp. 39. (Hillsborough, Co. Down: Agricultural Research Institute of Northern Ireland, 1948.) [209

Department of Scientific and Industrial Research: Road Research Laboratory. Road Research Technical Paper, No. 9: Computation of Traffic Stresses in a Simple Road Structure. By Dr. L. Fox. Pp. iv+28. (London: H.M. Stationery Office, 1948.) 9d. net. [229

Department of Scientific and Industrial Research: Road Research Laboratory. Road Research Technical Paper, No. 12: Properties of Road Tars and Asphaltic Bitumens in relation to Road Construction. By Dr. A. R. Lee. Pp. iv+23. (London: H.M. Stationery Office, 1948.) 9d. net. [229